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Eclipse Hunting in Brazil's Ranchland

By F. Barrows Colton

With Illustrations by Staff Photographers Richard H. Stewart and Guy W. Starling

HIGH on a rolling Brazilian plateau, on May 20, 1947, we kept a date with the vast, black, racing shadow of the moon.

On schedule to the split second, the shadow came speeding at 2,000 miles an hour across our camp site in the semi-jungle, and after more than a year of preparation and a flight of 6,500 miles we were there to meet it.

From within the shadow's cold half-twilight we saw Nature's most dramatic and awe-inspiring spectacle—a total eclipse of the sun.*

Our Army Air Forces–National Geographic Society Expedition did not travel so far merely to see a sublime celestial show. We made the trip to grasp a rare and fleeting opportunity, only 228 seconds long, to learn something more about that great hot star, our sun, around which our earth circles year after year and on which we depend for life itself.

That is the real drama of an eclipse—man, riding through space on his tiny planet, snatching one more chance to get a quick look at secrets hidden from him at all other times, secrets not only of the great star to which his fate is forever tied, but of other stars resembling the sun, and secrets as well of the vast universe far beyond his ken.

New Life Comes to Bocaiuva

Exciting rumors already had begun to spread in the sleepy little Brazilian town of Bocaiuva, nestling in the green hills of Minas Gerais State, 400 miles north of Rio de Janeiro, back in August, 1946, many months before that great day of May 20.

An advance party of scientists, khaki-uniformed officers of the U. S. Army Air Forces, and officials of your Society had appeared suddenly one day in this out-of-the-way corner of the world. Exploring the countryside far out into the tangled bush that covers the region roundabout, their bustling jeeps had startled the oxcarts and pack trains plodding along the rough, dusty roads (page 287).

Mysterious observations had been made by the visitors and there had been talk that the sun was to be blotted out.

Later the AAF officers had returned and engaged men to clear a large area on a hilltop at a remote spot out in the scrub forest, and to carve a long new airplane landing strip in the red earth at the edge of Bocaiuva itself, where large airplanes previously had been almost a curiosity (page 290).

And meanwhile, out in the empty depths of space, the barren, lifeless moon was slowly moving toward a point where, many months later, it would come between the earth and the sun and draw the end of its long, trailing, pencillike shadow across South America, the Atlantic Ocean, and part of Africa (map, page 295).

The inevitable coming of that shadow was stirring up preparations all over the world to observe the eclipse in Brazil. In the United States, scientists of six different institutions

* See, in the National Geographic Magazine: "Nature's Most Dramatic Spectacle," by S. A. Mitchell, and "Eclipse Adventures on a Desert Isle," by Capt. J. F. Hellweg, both in September, 1937; "Observing a Total Eclipse of the Sun," by Paul A. McNally, November, 1932; "Photographing the Eclipse of 1932 from the Air," by Capt. Albert W. Stevens, November, 1932; and, by Irvine C. Gardner, "Observing an Eclipse in Asiatic Russia," February, 1937, and "Crusoes of Canton Island," June, 1938.

During Totality Instruments Are Etched Against Light on the Horizon

This picture gives an impression of greater darkness than actually prevailed, because the photographer timed his exposure to catch the light in the distance and silhouette the instruments against it. A band of light extended around the horizon where the sun was shining outside the moon's shadow, which enveloped the camp (page 316).

under the auspices of your Society were building complicated instruments, testing cameras, and making precise calculations in their notebooks.

From Army headquarters orders were going out to assemble water-purification equipment, medical supplies, electric generators, rations, cots, mattresses, blankets, weather-observation apparatus, radios, and DDT spray bombs.

Officers and sergeants of the Air and Ground Forces who had seen service on the fighting fronts of China, India, North Africa, Europe, and the Pacific islands were getting travel orders again—this time for Brazil.

Thus preparations went forward at increasing tempo to keep our date with that shadow, which astronomers knew for a certainty would one day come racing across that very clearing that was being carved out on the hilltop beyond Bocaiuva.

Led by Dr. Lyman J. Briggs, chairman of your Society's Research Committee, 16 scientists, 55 officers and noncommissioned officers of the Army Air and Ground Forces, and five members of the National Geographic staff took part in our expedition.

Thanks to the enthusiastic cooperation of Gen. Carl Spaatz, commanding general of the AAF, it was the first large eclipse expedition ever to be completely airborne. All personnel, and 75 tons of supplies and apparatus, were transported by aircraft of the AAF's Air Transport Command from the United States to within a few miles of the expedition camp, saving incalculable time and making transportation infinitely easier.

General Spaatz further arranged for the AAF to operate our camp, make weather observations, and supply rations and pure water. The AAF also handled numerous details of arrangements in Brazil, through Brig. Gen. Gordon P. Saville, Chief of the Air Section of the Joint Brazil–United States Military Commission.

Keeping a Date with a Shadow

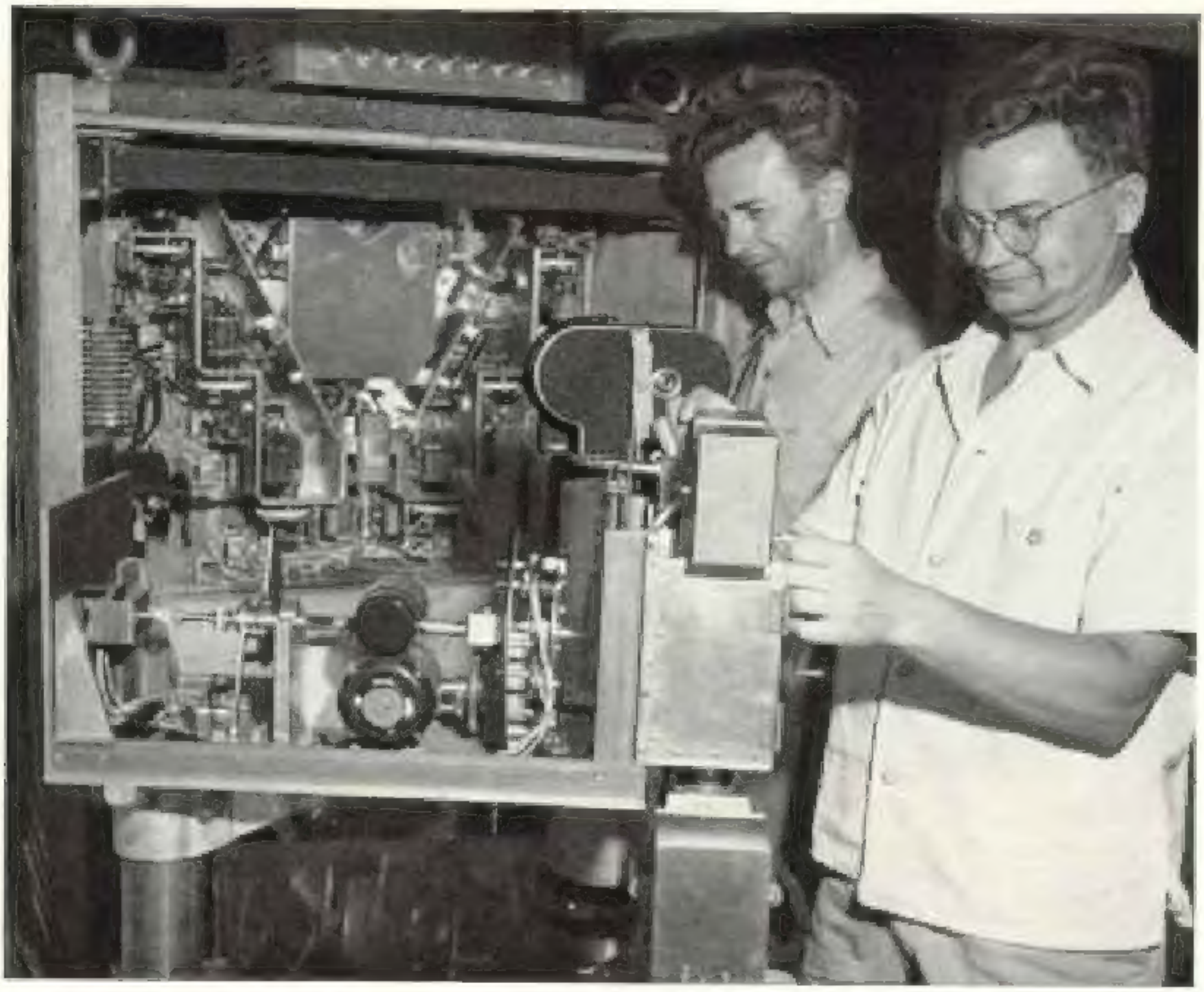
Keeping our date with the moon's shadow, we carried out one of the most complete programs of observations of a total eclipse of the sun ever undertaken. Our scientists, working feverishly through precious minutes, made hundreds of photographs and other observations. From these will come information obtainable in no other way concerning that all-important giver of life, the sun—how it affects the earth on which we live, how it

Transported by Air from Rio, a Water-tank Trailer Is Unloaded at Boeaiuva

Two of these trailers and seven jeeps were among pieces of heavy equipment flown to within a few miles of the camp. The trailers, lent by the Brazilian Air Force, hauled water from a stream. The plane is one of several C-47s of the Air Transport Command, which carried men and equipment.

Brazilian Pack-train Drivers Pause to Cook Lunch near the Expedition's Camp

Baskets piled behind them have been unloaded from their mules. The meal consisted of coffee and rice, meat, and beans prepared in the pot hung over the fire. Pack trains carry goods to and from the smaller towns in this comparatively undeveloped region of Brazil, where paved highways and railroads are few.



With This Maze of Apparatus They Probed 250 Miles Aloft into the Ionosphere

Radio signals, sent up to the radio-reflecting region high above the earth, echoed back and revealed what happened there before and during the eclipse. James Watts (right) and Franklin Kral of the National Bureau of Standards carried out the project, which will supply new information useful in long-distance radio communication. Movie cameras (center) recorded returning radio echoes on film (page 310).

rules some phases of our daily lives, and other knowledge which will reach deep into the heart of the atom and far out into the mysterious distant reaches of the great universe itself.

As we strapped on our parachute harnesses on April 1 and climbed aboard a huge four-engined C-54 of the Air Transport Command, we already were talking about the weather—not that day's weather, but the weather to come on May 20 at our destination in Brazil.

For every eclipse expedition is a gamble on weather, a gamble in which thousands of dollars, months of preparation, and weeks of travel are staked on the chance that the sky will be clear over the observation point at eclipse time.

An Astronomer Needs Luck

A total eclipse of the sun occurs somewhere on earth about every year and a half, but much less often does one take place in a location accessible enough and of a duration long enough to make it worth observing. No total eclipse can last much more than seven minutes, and most of them are much shorter, so that even with the best possible luck an astronomer can hardly hope to have as much as an hour of total time for observing eclipses in his entire life. No wonder, then, that the scientists joked a little hollowly about starting on April Fool's Day.

Flying southward, we gained a vivid impression of the far-flung, time-telescoping operations of the great Air Transport Command, and realized anew how today's air age has shrunk the globe. The big C-54s that carried various sections of our party could make the 6,500-mile trip from Washington to Rio de Janeiro in only three days!

Our course south followed the chain of great airbases built during World War II for the planes that flew by the thousands down to the territory of our loyal ally, Brazil, and

Eclipse Camp "Pioneers" Needed a Roof over Their Fire to Keep Off the Rain

Three soldier members of the expedition's advance party cook a meal outdoors under difficulties. Construction of the landing strip and main camp was begun during the rainy season under supervision of military personnel who arrived many weeks before the scientific group.

thence across the Atlantic to the African, Indian, and Chinese fronts.

While we were gazing down from above scattered clouds at the vast, swampy, jungle-clad delta of the mighty muddy Amazon far below, our navigator came aft to remind us that we would cross the Equator in a few minutes. The Polliwogs aboard, who never had crossed the Line before, began to fidget uneasily in their seats, while knowing grins appeared on the faces of the initiated old-timers.

Suddenly the pilot waggled his wings as a signal that we had crossed from the Northern Hemisphere into the Southern. In the excitement nobody happened to see Jupiter Rex come aboard, but there he was, complete with rope-yarn beard, crown, and flying jacket. (Jupiter initiates those who cross the Equator in the air, just as Neptune handles it on board ship.)

One by one the sheepish Polliwogs were herded back to the rear of the cabin, where they knelt before the Ruler of Winds and Weather to receive initiation into Jupiter's Empyrean Realm. Rising, they received a smart wallop on an appropriate portion of their anatomy, for flyers do not follow the shipboard ritual of ducking in a tank.

Over Rio's Famed Harbor

Late the next day we were circling for a landing over Rio de Janeiro's incomparably beautiful mountain-rimmed harbor.

Brazilian Army bugles from a fort on a near-by point, sounding shrilly through the pounding of the surf on world-renowned Copacabana Beach, woke us in our ocean-front hotel early next morning.

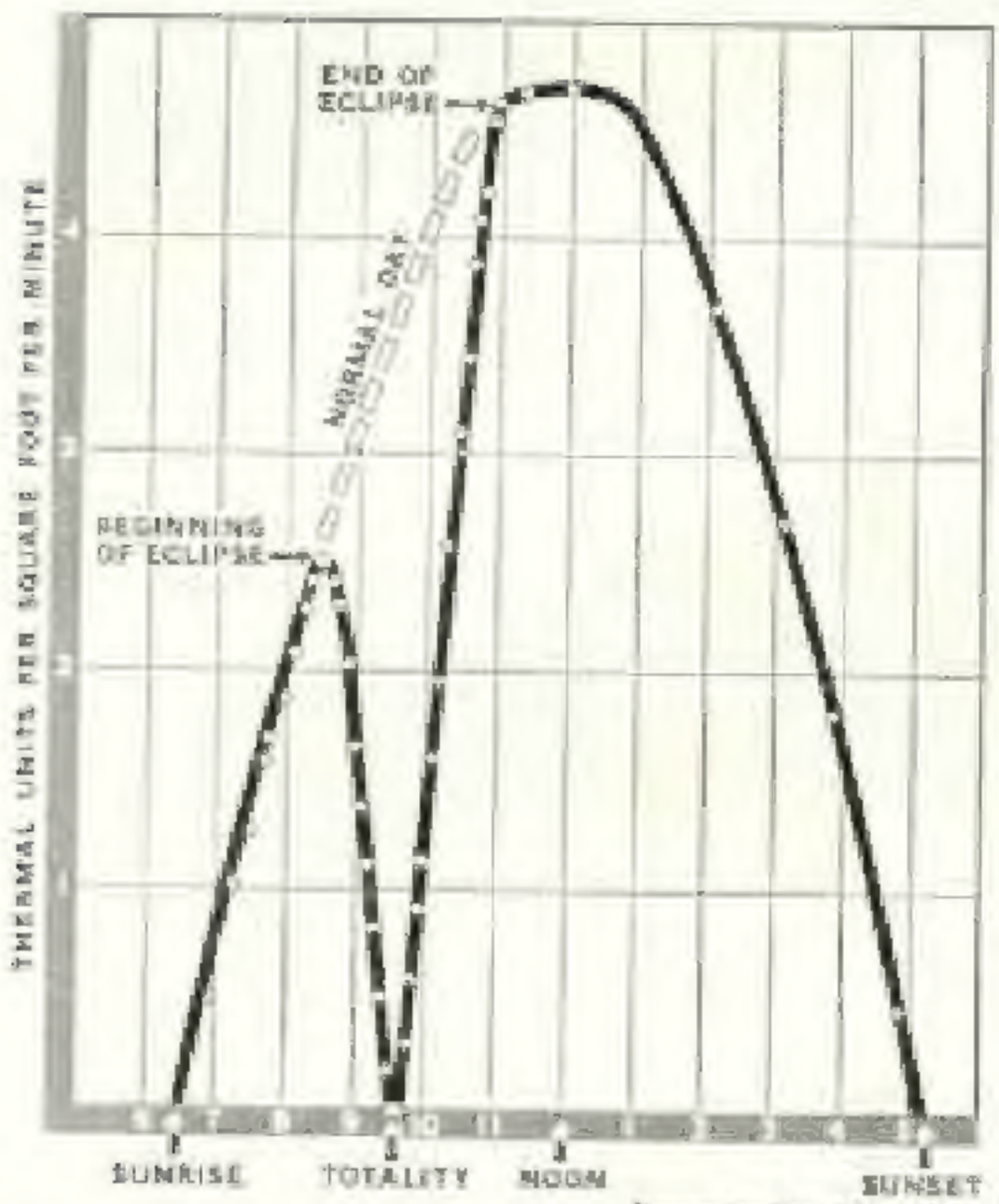
Soon we were flying again, this time in an AAF C-47 two-engined plane, over the lofty, rocky crags of the 7,000-foot mountain range that lies between Rio and Bocaiuva, 400 miles to the north.

Landing Strip, 3,750 Feet Long, Was Specially Built for Army Planes that Transported the Expedition to Bocaiuva

The mast carried antenna used in radio measurements of the ionosphere. Building housed airplane and vehicle repair shop, and kitchen (page 296).

"Camp Eclipse" Occupied a 12-acre Clearing in Scrub Forest on a Rolling Plateau in Brazil's Interior

Pyramidal Army tents served as living and working quarters (page 202). The building at left housed the mess hall and kitchen. Water tank on a tower is at extreme left. Eclipse observation area, with some instruments in place, is to right of center. Open grasslands mingle with the woods in the distance.



Drawn by Roy W. Collins

How Sun's Heat Dropped During Eclipse

The black line shows the heat starting from zero at 6:30 a.m., increasing until the eclipse began at 8:22, then falling off as the moon began to cover the sun, dropping to zero during totality from 9:34 to 9:38 a.m. It increases again as the moon moves off from the sun, reaches its high point at noon, and decreases to zero at sunset. Heat was measured by Dr. Lyman J. Briggs and AAF weather observers in British thermal units. One such unit is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.

Less than three hours later we had landed at the airfield specially built for the expedition's planes and were bouncing in jeeps over the 14 miles of country road out to camp, swallowing generous quantities of red, dry-season dust.

This road, originally a rough, narrow track through the bush, was widened and graded, and its primitive wooden bridges strengthened so that it could be negotiated by the Army trucks that transported our scientific instruments, equipment, and food supplies from the landing field to camp (page 291).

Your Society's Funds Build Base Camp

Incidentally, the entire cost of the airfield, improvement of the road, and construction of the camp, as well as the purchase of fresh food used in the mess, expenses of the scientists, and construction of their apparatus, was financed by research funds of your Society.

Bocaiuvans wondered why our camp was placed so far from town, out at "Extrema," as they called it. The reason was that it had to be located as near as possible to the center line of the path to be followed by the moon's shadow. Duration of the eclipse is longest at the center line, and our scientists wanted to make use of every possible second of the all-too-short period of totality.

A Cattle Rancher Aids Science

Use of the land was donated by its owner, Senhor João Antonio de Siqueira, a cattle rancher whose little adobe house sat beside a stream in a pleasant glade about a mile down the road. A friendly host, he visited us often, and the women of his family were kept busy doing our washing.

At the camp site, the advance party of Army personnel and Brazilian workers, starting weeks before in the mud and discomfort of the rainy season, had erected three dozen pyramidal tents in neat rows, and a semi-permanent building of adobe brick with a tile roof to serve as our mess hall and kitchen (Plate IV).

Under the efficient direction of Col. Paul C. Schauer, project officer of the AAF for the expedition, his able assistant, Maj. Jerome Alexander, and our hard-working camp commander, Capt. John M. Rice, the camp, run in standard Army style, became a little bit of home set down in the midst of this far-off patch of Brazil.

Almost everything, even to the heavy portable electric generators and our seven jeeps, had been flown to Bocaiuva by AAF transport planes, most of it all the way from the U. S. A. (page 287).

Only the big six-wheeled truck and three lighter trucks, or weapons carriers, had been driven under their own power from Rio as far as the condition of the roads permitted, then loaded on the narrow-gauge wood-burning railway that runs through Bocaiuva.

We had electric refrigerators for the kitchen, lent by the Brazilian Air Force, electric lights in the tents, mess hall, and camp "streets," and a public-address system that made it possible to page anyone in the broad camp area.

Field telephones linked the weather tent, radio tent, scientific laboratory tent, and headquarters of The Society's project officer, Melvin M. Payne, who was busy from dawn to bedtime with never-ending administrative details. The sheets on our Army cots were flown each week to Rio for washing, an 800-mile round trip to the laundry!

Under supervision of our doctor, Lt. R. V. Ramirez, water from a near-by stream was filtered and chlorinated (Plate XVI).

Just before sunrise each morning, at 6 a.m.,

Ben Grauer of NBC Describes the Eclipse "Play by Play" for American Listeners

From a platform overlooking the scientific instruments he views the gradual blackout of the sun through exposed film and sends an eyewitness account across 6,500 miles. Engineers installed special short-wave equipment by which the program was relayed to New York and broadcast on the NBC network. Four Brazilian radio networks also broadcast from the camp.

Actinometric Instruments to Measure Sun Brightness and Upper-air Temperature

[illegible]

ous horse-drawn wagon [illegible] Army cooks. Sat[illegible] Bill Vandiver, leaned on a [illegible] and sampled its stentorian tones. [illegible] A happy-go-lucky [illegible] to the old [illegible] and grin (Plate XXV).

Sleepy, tousled campers crawled [illegible] early from their warm [illegible] and lined up Army style at the mess hall for chow. A typical breakfast was fresh grapefruit, pancakes and bacon, cereal, jam, and coffee.

By 7 a.m. everyone was at work. From the [illegible] came the [illegible] of the Naval Observatory radio time signals from Washington, with which the chronometers were checked each [illegible]. At the same time could be heard the loud hiss of hydrogen gas being released from a steel cylinder to inflate one of the weather men's balloons; balloons went up four times a day around the clock.

As the balloon soared off into the blue sky, disappearing from sight, the little radio hanging beneath it sent back a continuous radio message to chart the temperature, pressure, humidity, and wind conditions far aloft.

Constantly in the background, day and night, was the throbbing hum of the motor generators, all-important equipment of the camp, supplying power for lights, radio, refrigerators, and scientific instruments.

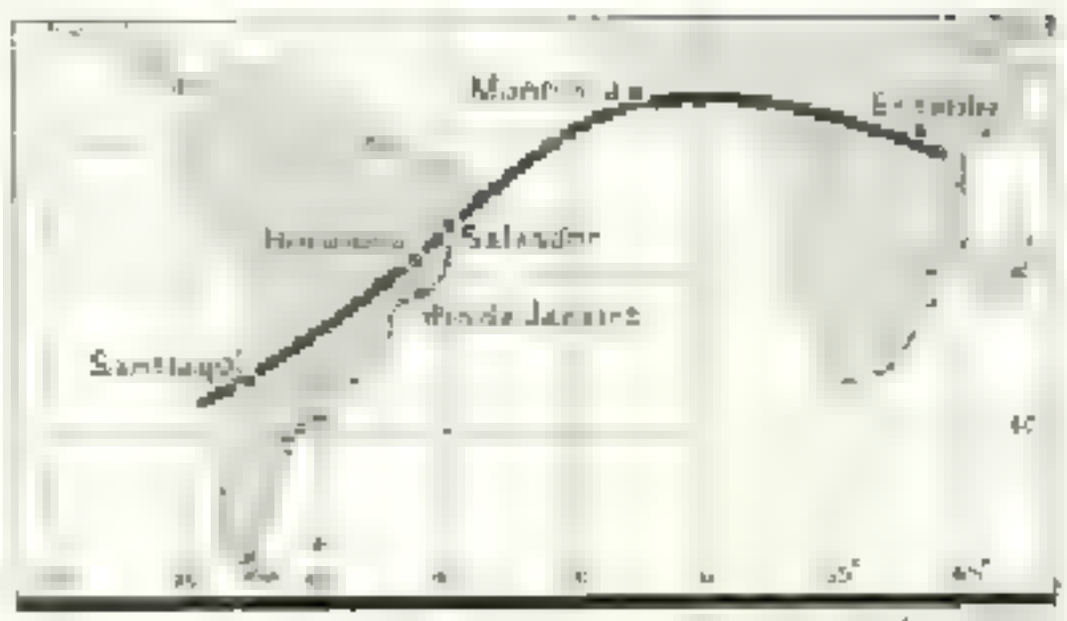
As work went forward, the camp presented a picture [illegible] the atmosphere of a [illegible]. Across the background of colorful flags and [illegible] tents, [illegible] changed across the field piled high with [illegible] colored boxes and packing cases.

Gangs of [illegible] Brazilian workers [illegible] Army [illegible] and [illegible] loaded the trucks, [illegible] huge solid wooden wheels, drawn by six or eight [illegible] oxen, [illegible] (Plates XII and XIII).

Visiting the camp, picturesque Brazilian cowboys [illegible] into camp, sporting leather hats, colorful [illegible] saddle blankets, and huge [illegible] sometimes strapped on bare feet. [illegible]

The total [illegible] was [illegible] by [illegible] Brazilian visitors, who [illegible] to stare [illegible] at the [illegible] sights, peer [illegible] and ask questions.

As the sun [illegible] higher, [illegible] stripped to the waist in the tropic heat. In the [illegible] Geiger counter [illegible] recording the passage of an invisible [illegible]



Eclipse Followed This Route Across Two Continents

[illegible] the path [illegible] by the moon's shadow [illegible] Africa [illegible] eclipse. [illegible] east to west.

[illegible] from [illegible] space. [illegible] day and night [illegible] Harvey [illegible]

Several of the camp [illegible] at [illegible] the [illegible] and dozens of [illegible] fresh fruit, pudding, or [illegible].

Snakes and Giant Ants

Most of [illegible] and [illegible] the camp by way of the [illegible] of game. [illegible] killed a snake near the edge of the clearing or stopped to watch the long processions of [illegible] giant ants [illegible] and carrying [illegible] of leaves [illegible].

[illegible] its way toward the [illegible] showers.

Camp Eclipse had [illegible] water except [illegible] the kitchen, but [illegible] washing clothes [illegible].

[illegible] another [illegible] of [illegible] vegetables, fruit, bread, and coffee [illegible] around a [illegible] table covered with a blanket. As the sun sank behind the western hills, the air almost at once became cool enough for [illegible] and sweaters [illegible].

At night the temperature often dropped to [illegible]

Ambassador Pawley and Brazilian General Coelho Were Among Eclipse Day Visitors

[illegible]

Southern Cross and other constellations of the southern Hemisphere are visible in the [illegible] skies.

Now and then [illegible] the [illegible]. [illegible] That vital [illegible] of [illegible] was provided through courtesy of the War Department Motion Picture Service.

Soon after 9 o'clock most of us were in bed [illegible] through the night hours.

But in the darkness of the [illegible] quietly [illegible] a telescope [illegible] the Milky Way [illegible] across the southern [illegible].

Father Francis J. Heyden, S. J., of Georgetown College Observatory, [illegible]

He [illegible] the southern Hemisphere [illegible] of the Milky Way [illegible] the north. [illegible] the [illegible] Father [illegible] S. J. [illegible]

At an hour [illegible] the soldiers of [illegible] before the [illegible] the [illegible] back the passage of [illegible] sky. [illegible]

[illegible] Brazilian [illegible]

Food and Supplies Brought In by Plane

[illegible] of the [illegible] Two of the [illegible] and [illegible] Kre[illegible] of the National Bureau of Standards [illegible] under command of [illegible] served as a [illegible] at the landing field near [illegible] by plane from Rio.

[illegible] and [illegible] for planes and motor vehicles were [illegible] up the [illegible] of the field [illegible] a plane [illegible] For a time [illegible]

Brazilian Scientists Calculate the Camp's Exact Location

[illegible]

General Pinheiro, of the Brazilian Air Force, Pays a Friendly Visit to Camp

[illegible]

Remarks Her Dogs Still "Hit the Spot" 6,000 Miles from Home

[illegible]

[illegible]

[illegible]

[illegible]

Photographing the Milky Way

As our months passed, some of our [illegible] [illegible] with the [illegible]

One was Barnard Hewitt's program of photographing the Milky Way. For great wonderful pictures of stars which shed [illegible] [illegible] the way in from the center of the wheel. In fact, all the Milky Way seems to come

most of space because we are looking out through the thickness of the wheel from the same [illegible].

Years ago Dr. Frank E. Ross, of Mount Wilson Observatory, made a series of fine photographs of the northern Milky Way with [illegible] camera.

Frank Ross borrowed his camera and photographed the southern part of the Milky Way, not visible from the Northern Hemisphere, on the same scale.

His photographs, added to those of Dr. Ross, will give a continuous picture of how the great star wheel looks from [illegible], so to speak, looking outward all the way around from the inside.

Balloon "Trains" Measure Cosmic Rays

Cosmic rays, little-known but powerful particles from outer space, were measured on the ground and at altitudes up to 80,000 feet by Geiger counters carried aloft by "trains" of eight balloons launched from [illegible] (page 303).

The balloon "trains" sent up by Martin Pomerantz and [illegible] were supposed to come back to earth [illegible] of cosmic rays which [illegible] with altitude. At 80,000 feet the total number of cosmic rays was 50 times that at sea level, and the intensity of the more penetrating rays was 10 times greater than on the ground.

All this was part of the great cosmic-ray research project being carried out under joint auspices of [illegible] Society, The Bartol Research Foundation of the Franklin Institute, and the Army Air Forces.

Weather information was collected continuously for more than two months by Maj. William L. Wolf and his 18 enlisted specialists of the AAF Air Weather Service. They measured temperature, pressure, humidity, and the speed and direction of the wind from the ground up to altitudes as high as 60,000 feet.

Their job was not to forecast the weather, but to gather data to be used by some of the expedition scientists in calculating results of other observations (page [illegible]).

Their weather data also will be added to the collection of world-wide weather information which is constantly being gathered by the Army Air Forces and filed for use by commercial airlines and other interested [illegible].

Measurements of the light intensity of parts of the sky at various times of day were made by Dr. E. O. Hulburt and [illegible] of the Naval Research Laboratory.

This information will be of great value in the design of an instrument which airplane navigators may use in seeing stars in the daytime [illegible] (pages 293 and 303).

As eclipse day drew nearer, preparations were intensified. One important task was establishing the exact location of [illegible] clearing on the vast [illegible] surface of the earth, for the observations to time the motion of the moon [illegible] the place from which they were made [illegible]. This job was done by Dr. Alirio Hugueney de Mattos and three of his assistants from the National Council of Geography of Brazil.

Working with these men, Brazilian [illegible] array of precision instruments, they calculated the latitude and longitude of a concrete monument in our camp within less than [illegible] feet of perfect accuracy—no small accomplishment on a globe nearly 25,000 miles in circumference! This monument [illegible] will become a permanent landmark in Brazil's national survey system (page [illegible]).

[illegible] newspaper reporters, and photographers [illegible] school children with their teachers [illegible] (Plate [illegible]). [illegible] troops [illegible] in full uniform with its [illegible] and bugles [illegible].

All Brazil [illegible] friendly interest in our expedition. Military and civil officials alike [illegible] water pipes, water-tank trailers, and [illegible].

A Brazilian [illegible] had charge of building our airport and improving our road. Brazilian Air Force planes [illegible] equipment from Rio de Janeiro. Many of us were [illegible] hospitality of Minas Gerais.

Why Observe an Eclipse?

Why is it important, people ask, to travel so far and spend so much time, effort, and money [illegible] a few fleeting moments of an eclipse of the sun? What can you learn, and what good comes of it?

Scientists can do a surprising number of things during the short span of an eclipse of the sun. They can time very accurately the motion of the moon through the sky. They can measure how much a ray of light from a distant star is bent as it passes the sun

another way of checking the [illegible] of records. They can get a quick look, indirectly, at the hot gases surrounding the outer layers of the sun and make records which will tell something about what those gases are and how they are behaving under conditions of temperature and pressure impossible to duplicate on earth.

Such information contributes not only to what is happening on the sun itself, but it helps explain the structure and behavior of other more distant stars. The sun is the only star near enough to us to appear as a disk on which different parts of its surface can be studied.

What is more, if it is possible to gather facts about the huge and titanic processes going on in the sun, [illegible] the vast reservoirs of energy the sun possesses and yields in its radiation, [illegible].

Something also can be learned about how the upper layers of the earth's own atmosphere are affected by the sun's rays, by noting what happens in the atmosphere when those rays are cut off during an eclipse.

What good is it all? In the first place, man is always trying to push the frontiers of his knowledge farther out into the unknown. Moreover, it seems only common sense to try to learn everything possible about the sun, [illegible] the most important thing in our lives. [illegible] this very "ordinary" star [illegible].

As the sun speeds on through the vast reaches of space, we are inescapably dragged with it on the end of an invisible but unbreakable chain of gravitation. Without its light and heat no life on earth could exist.

Ways the Sun Affects the Earth

Coming closer to home, there are [illegible] direct effects on earth every day that are of vital importance in our daily lives. The sun is the motive power of our weather. Its rays, shining down into the upper levels of our atmosphere, create the [illegible] of the ionosphere, [illegible] radio waves sent [illegible] communication [illegible].

These same rays create [illegible] conditions of temperature and layers of ozone and other gases in the upper atmosphere which we need to know about in this age when stratosphere planes, high-flying rockets, and guided missiles are penetrating into a [illegible] world of ever greater altitudes.*

The last [illegible] plus the desire to support [illegible] of relativity, [illegible] the [illegible] National Geographic Society was interested in having the Army Air Forces [illegible].

The Principle of Relativity

One of the [illegible] of modern science, Einstein's theory of relativity, [illegible] played an important role. Einstein's [illegible] such as [illegible] that mass and energy [illegible] and that energy and [illegible] weight are the same thing. [illegible] "practical" [illegible].

It has helped explain the structure and behavior of the atom, and thereby is playing an important part in the development of atomic energy, both for peace and for war.

One of the assumptions upon which Einstein's [illegible] rests [illegible]. [illegible] to understand [illegible] to grasp the [illegible] position of the experiment.

Einstein [illegible] predicted that, as a test of his theory of relativity, he [illegible] that the rays of light from distant stars would be bent slightly as they passed near the sun. He said that this bending would be equivalent to a very small angle, [illegible] of one degree, one and three-quarters seconds of arc. That is the angle made by two straight lines [illegible] long, touching at one end and [illegible] at the other.

The bending of starlight is caused by the gravitational attraction of the sun, pulling the light rays slightly away from a straight path as they go past, as though they had actual weight.

Dr. George Van Biesbroeck, of Yerkes Observatory, set out to measure that bending. [illegible] by making two photographs of the same group of stars, one during the eclipse and another when [illegible] returned in [illegible] the telescope was left in position. [illegible] this group of stars [illegible] the sun during the eclipse [illegible] compared [illegible] the night sky [illegible] the same position in which they were located [illegible].

[illegible] during the eclipse, the stars around the edge of the sun [illegible] passing [illegible] on the way to the earth, [illegible] on the photograph [illegible] than [illegible] in the sky.

On the [illegible] when [illegible] the [illegible] from

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* See "[illegible]," by [illegible], in the National Geographic Magazine, [illegible].

Full Glory of the Corona Bursts into View as the Moon's Disk Covers the Sun

[illegible]

Huge Red Hydrogen Flares on the Eclipsed Sun Extend Out Beyond the Moon's Rim

Edge of the Advancing Moon Seems to Touch the Sun. Note Group of Sunspots

At the Instant Totality Ends, the "Diamond Ring" Effect Appears

Flags of Brazil, the United States, and Your Society Fly Before the Expeditioner's Brassard-ridge Mess Hall

Wearing Oxygen Masks and Heated Suits, This Army Air Forces Crew Photographed on Tripoli from 30,000 Feet

With Muzzles Aimed Aloft Like Heavy Guns, the Expedition's Instruments Stand Ready to "Shoot" the Eclipse

[illegible]

Spectrograph Breaks Up Sunlight into Rainbowlike Spectrum

Foreign-looking Markings Show This Camera's Wide Travels

This Big Telescope Might Provide a Way to Check Einstein's Theory of Relativity

[illegible]

the stars will not be seen, and the stars will appear in their true positions.

Measuring the difference in the star positions on the two photographs, Dr. Van Biesbroeck can determine how much their light was bent in passing the sun and see if it was as much as Einstein predicted. If the angle comes out as Einstein said, it will be new evidence that the theory of relativity is correct.

Dr. Van Biesbroeck had to make the first photograph during the eclipse because only then, when the sun's light was blotted out, was it possible to catch on the photographic plate the faint images of stars that are drowned out in the sun's brilliance at all other times (Plate VIII).

Earth's Atmosphere Bends Starlight, Too

Einstein has interpreted the bending of starlight at previous eclipses, but their results varied. One difficulty was that the starlight was bent not only in passing the sun but also by refraction as it passed through the earth's atmosphere. To allow for the bending caused by the atmosphere, one needs to know the temperature, pressure and [illegible], since they govern the refraction.

During the eclipse the NAF weather men sent up balloon-borne radiosondes that radioed back the temperature, pressure and humidity at heights up to 70,000 feet, and Dr. Briggs measured temperatures near the ground (page 502). These data will help Dr. Van Biesbroeck to calculate more accurately how much bending of the starlight was caused by the atmosphere and how much by the sun.

As a further aid to accuracy, he photographed on the same plate not only the eclipse with its stars, but [illegible] of their light but also groups of stars off to one side in the sky, reflected into the telescope by a mirror.

Since the light from these stars did not pass near the sun, it was not bent, so these "check" groups of stars will be in the same position on both pictures, providing an unvarying yardstick of reference to show whether temperature or other changes in the telescope caused slight variations in scale in the two pictures taken three months apart.

Results of Dr. Van Biesbroeck's research will be awaited with the greatest interest by scientists all over the world.

Among the practical measurements were the timings of the instants of the beginning and ending of totality by Drs. Herzog and McHugh of Georgetown. They measured precisely the times of the "contacts" during the eclipse.

These are the times when the edges of the sun and moon appear to touch—first, as the moon's edge begins to move in front of the sun, second when it has completely covered the sun's disk, third when the sun begins to reappear, and fourth when it moves clear of the sun and loses contact at the end.

Checking Schedule of the Solar System

Timing these contacts is a method of checking up on the solar system to see if it is running on schedule. It shows whether the astronomers who forecast the eclipse made a correct calculation of when it would begin and end. It also applies to predictions of future eclipses, and is useful in calculating backwards to learn the dates of eclipses of the past, knowledge which sometimes helps in fixing the dates of historical events. It also gives a further check on the coordinated movements of the moon and earth.

The eclipse aids the accurate prediction of the times of high and low tides, information essential to mariners. Incidentally, the [illegible] is gradually [illegible] the earth.

In timing the contacts, Herzog and McHugh made a series of photographs which show the moon gradually covering and uncovering the sun. On these pictures, by careful measurements, they can determine the times of contact more accurately than is possible by eye, and find the actual moments when the edges of the sun and moon seemed to touch.

Among the other results of the expedition was the work of two spectrograph operators, Dr. C. C. Kiess of the National Bureau of Standards (Plate VIII) and Dr. Harold F. Weaver of Lick Observatory.

For countless millions of years atoms of hydrogen in the sun have been combining to form atoms of helium. In the process a great amount of matter is converted into the energy which keeps the sun blazing with its terrific heat.

Each chemical element in the sun and stars gives off, when excited by heat, waves of light vibrating at certain frequencies, differing frequencies for each element. With the spectrograph it is possible to split the sun's light into a rainbow-like spectrum, or arrangement of lines in which each element can be identified by its own lines which represent its special frequencies.

[illegible] interest and [illegible] as the [illegible].

By studying these spectra it is possible to tell what chemicals are present in the sun

[illegible] to investigate the behavior of [illegible] during the [illegible] and [illegible] of these areas.

Ordinarily, only a small part of the sun can be seen; the light from the various layers is mixed together. But at the time of an eclipse, just before the moon covers the edge of the sun, each layer appears for a brief time along the edge of the moon, and its spectrum can be photographed before the light from the other layers mingles with it.

Mysteries of the Corona

The corona—the pearly streamers that surround the sun at eclipse—is a thin envelope of gas whose nature still is not fully understood (Plate I).

One of the mysteries of the corona is that it contains atoms of very highly ionized metals, such as iron, that is, atoms from which many of their electrons have been stripped off, a process requiring tremendous energy.

Some astronomers believe that these strange [illegible] take place in the corona; others that the atoms are thrown from within the interior of the sun by the great heat prevailing there, and then spread into the corona through openings in the sun's surface. Studies of the spectra of the corona, photographed during the eclipse, would help solve this problem.

Unfortunately, the spectrographs, which had worked well during rehearsals before eclipse day, failed to function properly at the critical time, so that the full program of observation could not be carried out.

Some answers to the secrets of the sun's corona were obtained, however, by the cameras of Dr. Irvine C. Gardner, [illegible] (Plate VII), and his assistant, Mr. Lee W. [illegible], both of the National Bureau of Standards. Using special lenses and filters, they made photographs of the corona to determine the nature and amount of its light, the extent of its long streamers, and how its light was polarized—that is, how it vibrates in only one direction.

The amount of polarization of the corona's light will help determine how much of it is sunlight reflected by small particles.

Pictures of the corona also were taken by [illegible]. These show streamers extending out to a distance equal to two or three diameters of the sun.

Other members of the expedition studied the upper atmosphere many miles above the earth to ascertain what happened there when the sun's light was cut off during the eclipse. They used new means of studying radio and sky brightness to measure intensity of light from the upper heavens before, during, and after [illegible].

Dr. Hulburt and Ralph Havens measured the temperature of the upper air at great altitudes, up to perhaps 40 to 80 miles, which it is possible to measure by no other means except rockets.

As the moon's shadow gradually moved over the earth, they looked [illegible] to the [illegible] regions where [illegible] of the [illegible] were still [illegible].

Measuring with great precision the light reflected back to earth from these regions, it was possible to estimate how many atoms there were in the region beyond the shadow [illegible] to the top of the atmosphere. From this can be calculated the temperature and pressure at these high altitudes.

Builders of high-flying aircraft and guided missiles and rockets will greatly welcome such information, as [illegible] to the upper air [illegible].

Dr. Hulburt also measured the diminishing brightness of the sun as it was gradually covered by the moon, which will help reveal [illegible] of the sun [illegible].

From the ionosphere measuring stations, James Winters and [illegible] Kri[illegible] [illegible] to [illegible] off the electron-bearing region in an [illegible] to [illegible] what happened there during the eclipse. [illegible]

The ionosphere is created by ultraviolet light and other radiation from the sun acting on the upper air and making it electrically conducting. [illegible]

Effects on Radio Signals

The radio signals coming back from the ionosphere indicated that, as might be expected, when the sun's light was cut off during the eclipse the layers decreased in [illegible] somewhat as they do at night, but the character of the disturbed layers was different from what it is at night.

The echoes were recorded on movie film daily before the eclipse, to indicate normal conditions, and during the eclipse itself. When the film is run through a projector it shows [illegible] of the layers [illegible] up and down and varying in intensity. At the time of the eclipse the moving film shows the layers changing in height, thickness, and density.

After leaving the eclipse site, [illegible]

With a Hydroplane Riding, Flex Messers Wards and Weather Ten Miles or More Aloft

[illegible]

[illegible]

[illegible]

Lens of a Giant Eclipse Camera Gets a Final Cleaning

[illegible]

Expedition's Military and Scientific Leaders Compare Notes

[illegible]

Big Balloons, to Be Hitched Together in Tandem, Are Inflated to Carry Cosmic-ray Measuring Apparatus Aloft

Eclipse Flight of the B-17 Is Charted on Your Society's Map of South America

[illegible] the [illegible] Brazil [illegible]. The crew [illegible] Wright Field, Ohio.

Others made observations of the ionosphere, cosmic rays, and the influence of the eclipse on the temperature of the air and its electrostatic conditions.

On the day before the eclipse some of us, wondering what tomorrow's weather would be, began to get pretty nervous. But Dr. Van Biesbroeck, whose earlier [illegible] in making one single, crucial photograph was [illegible]. Just before supper I [illegible] him at the [illegible], doing some [illegible], as if tomorrow were [illegible].

"Are you an optimist?" I asked.

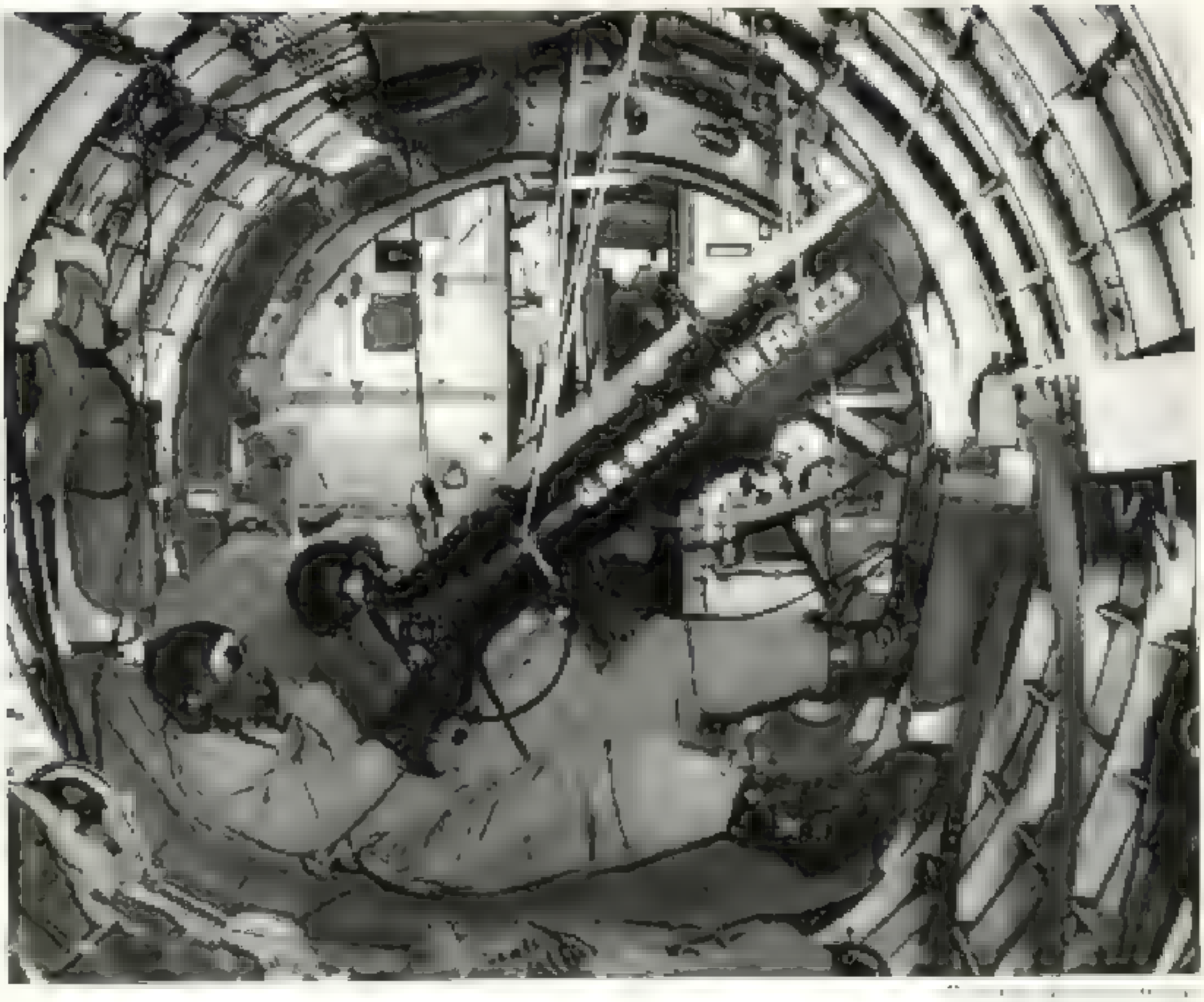
"No," he replied with a twinkle in his eye. "I am prepared to be disappointed!"

Eclipse day dawned bright and clear. But [illegible], thin waves of high cirrus clouds, composed of crystal ice particles, [illegible] across the sky from the west, with [illegible] between World [illegible] the details of [illegible] eclipse [illegible]. Would the [illegible] of these [illegible] when the [illegible]?

That was the question in everyone's mind as we gulped an early breakfast and turned to make last-minute preparations. A number of distinguished visitors were in camp to see the show, including the U. S. Ambassador to Brazil, Hon. William D. Pawley; Brig. Gen. Gordon P. Saville; Brig. Gen. Francis L. Ankenbrandt, chief observer from AAF headquarters; and many Brazilian [illegible] (page 290).

Spectators began to drift in. Bill [illegible] of NBC and the announcers of other Brazilian radio stations began their preliminary broadcasts. Two airplane loads of Brazilian and American newspapermen arrived from Rio, [illegible] in time.

Meanwhile [illegible] that morning,



AAF Cameramen Breathe Oxygen as They Photograph the Eclipse at 30,000 Feet

Lying on [illegible] Army Air Forces [illegible] B-17 [illegible] [illegible] [illegible] the eclipse [illegible]

the AAF photographic crew in the *Brazilian* [illegible] B-17 equipped with still and motion cameras, took off to photograph the eclipse from high altitude (Plate VI). These crewmen would be up for six hours, breathing oxygen during the entire time as they cruised back and forth within the moon's shadow taking motion pictures (Plates II and III).

First Contact!

Everyone was at his station. It was 8 o'clock now, and first contact, when the moon would begin to move down across the sun, was at [illegible]. [illegible] was already broadcasting the [illegible] [illegible] thermometer recording of the [illegible] [illegible] [illegible]. Then the [illegible] voice broke in: "Two minutes to first contact! . . . [illegible] . . . *first contact!*"

Exactly on schedule, as [illegible] had been waiting for [illegible], the round edge of the moon began to bite into the upper edge of the sun. A murmur went up from the crowd.

[illegible] Father Heyden [illegible] like a well-drilled [illegible] crew (Plate X). He and Father McHugh [illegible] Dr. Edgar [illegible] of the AAF [illegible] photograph the [illegible] [illegible] seconds [illegible] until [illegible].

Dick Stewart and Ray Phelps [illegible] their movie cameras (Plate XI). Stewart was making a [illegible] film on the entire expedition. Phelps's [illegible] to the [illegible] Studios for showing over the NBC television network.

The [illegible] continued to [illegible] second [illegible] with the [illegible] calling off [illegible] intervals. Shortly the [illegible] photographer [illegible] was moving [illegible] over the sun

[illegible]

Darkness and Cold Creep over Earth

[illegible]

The "Diamond Ring" of Totality

[illegible]

Eclipse Drama Reported by Radio

[illegible]

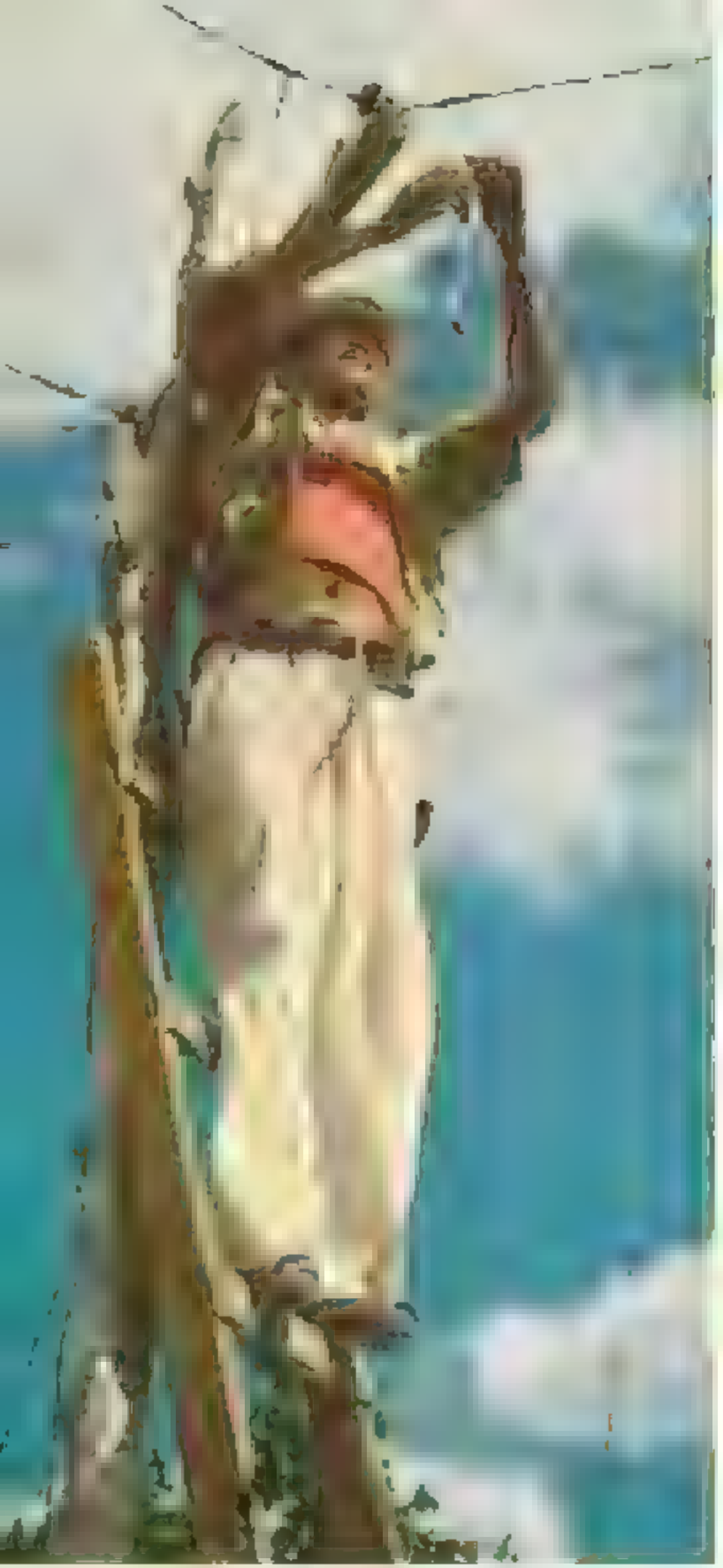
His Camera Photographs the Eclipse Reflected in a Mirror that Follows the Sun

Protecting Their Eyes from the Glare, Brazilian Natives Watch the Eclipse

Here Photographed the Eclipse Exactly 15 Seconds Two Hours Long and a Half Hours

Part of the Russian Scientific Council of Vasiaev Bears the Expedition Equipment

Dr. Carl C. Kiess Describes the Instruments to Visiting Brazilian Officers



Brazilian Workmen Strung Wires and Erect the Photographic Dark Room. Local Labor Built Most of the Camp

Slow-moving Oxcarts Haul Building Materials for the Expedition Camp Through Scrub Forest Typical of the Region

City with Colonnade, Flowers and Shrubs, Beautiful Main Square Busier with Activity on Weekly Market Day

Brazilian Sappers Buy Meat, Chickens, and Produce Brought by Oxcart Back Home, and on Foot

Sample of Camp Dressing Wounds Was a Chemical Test from the Doctor [illegible]

Sgt. Bill Vaughan, Camp Cook, Plays with His Tame Green Producers

[illegible]

Exploring America's Great Sand Barrier Reef

By Capt. Eugene R. Guild, USA, Ret.

With Illustrations by the Author and Staff Photographer John E. Fletcher

FOR [illegible] Chesapeake Bay, North America's [illegible] barrier reef of sand [illegible]. [illegible] Hatteras [illegible] Virginia [illegible].

[illegible] sand [illegible].

[illegible] miles. [illegible]

[illegible]

[illegible] hurricane [illegible] sand [illegible].

[illegible]

[illegible] through the Land [illegible] Cape Henry, past the [illegible] of Virginia Beach [illegible].

[illegible] Kitty Hawk; thence past [illegible] Hill and the Dunes of Dare to the island of Sir Walter Raleigh, called Roanoke.

Still southward I drove to Oregon Inlet [illegible] to the candy-striped lighthouse of Cape Hatteras.

Then I turned with the coast abruptly [illegible] to Hatteras Inlet. [illegible]

A Coast of Many Moods

[illegible] moods, so [illegible] the sea. [illegible]

But on every day [illegible]

Some [illegible] are boisterous [illegible]

I [illegible] this land. It is a world of sand. [illegible] the ripples and in the [illegible].

[illegible]

But there is much to learn about sand [illegible] the [illegible].

For 150 Years Cape Henry Lights Have Guided Ships into Chesapeake Bay

[illegible]

Road Dredge's Nightmare: Stuck in the Incoming Tide!

Sophisticated Scamps Bear Witness to an Unfortunate Error

Who's the Most Popular Man on Any Beach?

[illegible] Virginia Beach [illegible] on the beach. [illegible] (Plate [illegible]).

1607. It is a good spot [illegible] to the sand [illegible] the dunes. [illegible] than Captain John Smith's chart.

Vagrant Cape Henry

This is not the first time Cape Henry has gone on a pilgrimage. It was once some miles to the south. Were it to return to its old place, the summer resort at Virginia Beach might be embarrassed to find itself two miles inland in a dense forest.

I saw evidence of its former location in the old stumps and peat beds which are sometimes uncovered at low tide near the resort. The Army has placed [illegible] at the tip of the cape in an attempt to prevent further movement.

Thanks to the [illegible] over the cape, I was able to "trace its growth" [illegible] lines of ancient [illegible] which were easily readable as [illegible]. The story they told [illegible] of sandbars followed by dunes.

At each new stage a dune was formed. Those behind it became covered, first with [illegible] grasses, then with bayberry, and finally with trees. Thus was built up the cape, [illegible] miles broad and three miles in depth.

I [illegible] could see where the [illegible] had changed since [illegible] landed on the cape in 1607. The sea had [illegible], throwing up a great marching dune three miles long, which rolled [illegible] steadily westward.

Between the great "desert" dune and the shallow bays behind the cape, sheltered from gales from the sea as well as from cold blasts out of the north and west, a wilderness grew [illegible] oaks, beeches, [illegible] alternating with ponds [illegible] with cypress and tupelo. This wilderness has been known to Virginians at least since


Hampton
Newport News
Norfolk
Portsmouth
Virginia Beach
Princess
Suffolk
Anne
County
VIRGINIA
NORTH CAROLINA
Elizabeth City
Edenton
Dare
County
Stumpy Point
Manteo
Roanoke Island
Rodanthe
Avon
Buxton
Cape Hatteras
Ocracoke Island
Portsmouth Island
Portsmouth Bank
Core Bank
Beaufort

Checking In at a Canine Hotel in Norfolk

[illegible] Virginia [illegible] Norfolk [illegible] North Carolina.

[illegible] with plans to put men to work, [illegible], cutting, trimming, and scientifically [illegible] landscaping [illegible] the [illegible]. They started to shift the Friendly Trail [illegible] 75-foot [illegible] and had [illegible] around the [illegible] along the edge of the [illegible].

But the women of Tidewater Virginia [illegible] the Desert and its trail [illegible] urged [illegible] The Desert's [illegible] would [illegible] the [illegible] would stop. A bit of Virginia's disappearing wilderness area was reserved at Cape Henry.

Leaving the cape, I drove [illegible] the [illegible] and [illegible] my way [illegible] the [illegible]. With [illegible] driven [illegible] the [illegible] of [illegible] I [illegible] down [illegible] the hard [illegible] of the wash. My [illegible] was a [illegible] strip [illegible] by a recent storm.

[illegible] had been planted. They have thriven, and when I returned this year the nesting [illegible] was [illegible] at the same [illegible] I saw a young [illegible] of [illegible] tall.

The Desert Is Rescued

[illegible] the Desert was threatened from another direction and I [illegible] wonder [illegible]. It [illegible] a [illegible] and [illegible] all over the country. A [illegible] wandered through [illegible] a wilderness [illegible] trees and dogwood [illegible] window [illegible] drawn in.

Suddenly the Government [illegible] upon

[illegible] the back about what [illegible] had [illegible] to [illegible] possibility. So I [illegible] slowly, [illegible] to [illegible] and the [illegible] the [illegible] as I went, and [illegible] at the [illegible] was [illegible] later.

For a while the wash was level; then I reached a stretch of [illegible] where [illegible] of the rear seat found themselves in a continual state of [illegible]. [illegible] stretch of [illegible] a [illegible] but the [illegible] upon the dry land until the [illegible] lake shore.

A half dozen miles or so south of Virginia Beach I turned inland to search [illegible] countryside of Princess Anne County. They told me, [illegible], a small-[illegible] witchcraft story of [illegible] New England. I found that as Massachusetts has had its Salem witch hangings, so Virginia has had its Princess Anne witch duckings.

Here Witches Were Ducked

Ducking was not as harmless as it sounds. A woman accused of witchcraft was stripped of her clothing, bound, and cast into the water. If she floated, she was guilty and was generally hanged. If she sank, she was innocent—[illegible] being saved from drowning, [illegible] of her innocence.

Grace Sherwood was Princess Anne County's famous witch. The record of how she was ducked in 1706 for being a witch [illegible] named Witch Duck [illegible], and thrown into the water by the sheriff.

The after-story is gratifying, however. [illegible] 80 [illegible] and died in bed.

Returning to the beach, I resumed my hike [illegible] to False Cape, where the beach widens and becomes as flat and smooth as a [illegible]. [illegible] speed [illegible].

But I paused for [illegible] and had to turn back for another look. They were [illegible] which [illegible] too large to handle [illegible] of any [illegible].

Amphibious Pigs Like Sea Food

Some [illegible] dots on the [illegible] beach [illegible]. We stared at one another for a while, and then the pigs went back to [illegible] under the edge of the water. They were [illegible] little [illegible], which is about the shape and size of a pigeon's egg (page [illegible]).

There were hundreds of these [illegible] just under the sand, and they [illegible] the edge of the water as the [illegible] in and out. As the [illegible] of each wave receded, I could see the V-shaped marks made in the sand as they spread their antennae to catch [illegible] before [illegible] under the sand.

The [illegible] but [illegible] and [illegible] I understood that [illegible].

Now in [illegible] North Carolina, I [illegible] Hill, [illegible] for a preview of what was to come. Four miles to the south, among great yellow dunes, was the [illegible] Currituck Beach [illegible]. On my right was Currituck Sound, [illegible] miles wide and [illegible] miles long.

Many years ago there was an inlet [illegible] and the water of the Sound was salt. Then a great [illegible] and the water turned fresh. The State [illegible] the water [illegible] because [illegible].

As I [illegible] I began to [illegible] on the beach. There were several [illegible] and a number of [illegible]. In the [illegible] I counted 17 [illegible] from Cape Henry to Hatteras Inlet.

Chronicles of Whale Head

I crossed the [illegible] to Currituck Beach Light and the [illegible] at its foot. Locally the [illegible] Whale Head for the [illegible], Currituck [illegible] for the light, and Corolla, North Carolina, for the post office. Few [illegible] travelers suspect its presence beyond the dunes.

[illegible] narrow lanes [illegible] which on that day were alive with [illegible] warblers, mockingbirds, and cardinals. Children were playing under the [illegible] around the white [illegible], and a cow and some chickens foraged on the grass-grown [illegible] by the general store.

Currituck Beach Light is an unpainted red-brown brick tower [illegible] the ruddy cheek of an old sea captain. It fills the [illegible]-mile gap between Cape Henry Light and Bodie Island Light at Oregon Inlet, warning against a coast that is a dangerous lee shore when [illegible].

At such times the surf is incredibly violent. Mighty seas roll forward and crash, [illegible] tons of water [illegible] down. They [illegible] men to [illegible] even before [illegible] them, and [illegible] as if they were of [illegible].

Such was the surf which took its toll in sight of the light on the last day of January in 1878, when the *Metropolis* was wrecked

Peace along the Hatteras Reef Makes a Place in the Endless Strife Between Sea and Sand

Spray Flying, a Coast Guard Lifeboat Fights Its Way Through Choppy Surf near Oregon Inlet

[illegible]

Pace Of Crashed to Tahoe: A Wide-winged Osprey, the Reel's Best Fisherman, Begins Its Northward Flight

A Drive on the Reefs Treacherous Twice Round May Prove to Call for the Coast Guard or a Cat, or a Lifeboat

Knuckle Deep, Aspirants Pickers Root for More Crabs Which Migrate with the Tide on the Great Sand Barrier Reef

Gaping with Cutlass Wounds, a Pirate's Current-sculptured Head Lies Beneath the Waters of Hatteras Inlet

[illegible] Blackbeard [illegible] Ocracoke Inlet [illegible] In 1718 Lt. Robert Maynard of the Royal Navy surprised the [illegible] and killed him in personal combat.

There is an unsolved mystery, too, still hanging over this beach. Keeper [illegible] and [illegible] were lost when they went out in their surfboat to the aid of an Italian bark. No one knows what happened there, but some think they would've been [illegible] by the ship's crew, who mistook them for wreckers.

A view is [illegible] a [illegible] in bringing the crew ashore. [illegible] the ship's crew [illegible] and start north toward the Chesapeake. A lifesaving crew farther north had to row out and convince them that wreckers did not await them ashore.

The old light has seen strange things, but none was stranger than the occurrence of December 1862. Just to the north of it, [illegible] went down in a gale. It was the [illegible] *Monitor*, one of the first in our Navy.

Orville Wright's Telegram

While the Nation was busy watching to see whether it would be [illegible], something [illegible] happened at Kill Devil Hill, 25 miles to the north. As a result of it two brothers walked over to the Kitty Hawk weather station to send a telegram. Relayed to Norfolk, it was addressed to someone's father in Ohio, saying, "Success four flights Thursday morning . . . home Christmas." The message was

sighted by a man named Orville Wright.*

Below [illegible] Beach, I [illegible] I met a whale on the [illegible]. He was a pilot whale or blackfish about 1[illegible] feet long, and he had not long been separated from [illegible].†

A teen-age girl stood near by, giving him [illegible]. [illegible] the whale sighed [illegible] and [illegible]. [illegible] in a [illegible] struggle [illegible]. He had evidently struggled a long time to get afloat and was [illegible].

The pilot whale seems to be subject to [illegible] panic, and a leader will suddenly dash ashore, [illegible] the rest of the herd. I wondered what [illegible] these [illegible] whales.

[illegible] Some [illegible] and [illegible]. He [illegible] a [illegible]. But he was [illegible] not quite [illegible]; he was [illegible].

Nevertheless, I [illegible] for him, and later I was relieved to find that he got afloat on the next [illegible].

Helping Hands in the Sand

[illegible] of [illegible] when [illegible] reminded me [illegible] of a [illegible].

There was no sign of [illegible] or human [illegible] from horizon to horizon, and at [illegible] I [illegible] up [illegible] a Coast Guard [illegible] I [illegible] its [illegible] wheels [illegible].

Then [illegible] labeled "Dare County Schools." It was [illegible].

No traveler on the beach passes another without [illegible]; it is unknown for [illegible] to pass a stopped car without offering aid.

I [illegible] at the site of old [illegible] near [illegible] Sound. [illegible] where [illegible] the [illegible] across the [illegible] of the [illegible] in [illegible] North [illegible].

Near Kitty Hawk I crossed the paved Wright Memorial Highway. [illegible] of which have [illegible] a [illegible] of the daughter of Aaron Burr.‡

For [illegible] the [illegible] *Carl Gerhard* came ashore in 1930. She sat there for some years on an even keel [illegible]. Under them is [illegible] bridge [illegible] the smooth sand on the [illegible].

America's Greatest Barchan

Four miles south of Kitty Hawk Coast Guard Station, and about a mile inland, rises what was once the largest and most nearly perfect barchan, or crescent-shaped dune, in the United States. It is 91 feet high: Kill Devil Hill. From December, 1903, when the Wright brothers made their first flights, until the dune was stabilized in [illegible], it traveled south [illegible] feet, or roughly [illegible] feet each year.

This rate of travel [illegible] of North America. [illegible] feet long, [illegible] than Kill Devil Hill [illegible] feet per year.

I saw the great dune before man laid a restraining hand upon it. It was [illegible]. Now it has been covered with [illegible] planted to grass and weeds to stop its movement. A [illegible] stands on its summit, a memorial to the Wright brothers' first flights.

[illegible] with [illegible] of walks and drives around it. Those who love the wildness of the [illegible] of the sea would [illegible] to see the dune covered with [illegible] which [illegible] has preserved [illegible].

From the top of Kill Devil Hill I could see to the south across [illegible], Roanoke Island, site of the first English colony and the birthplace of Virginia Dare (Plates VI, VII). [illegible] Island in [illegible] Sound.

There I learned that the Lost Colony of 1587, which antedated Jamestown by 20 years and Plymouth by 33 years, [illegible] perhaps several centuries older.

Some years ago, so the story goes, a [illegible] live oak growing on an Indian shell mound was uprooted in a storm. [illegible] were two carved pipes [illegible] Indian in design or [illegible]. They were [illegible]

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* See "[illegible] North Carolina," by [illegible], National Geographic Magazine, May, [illegible].

† See "Whales, Giants of the Sea," by Remington Kellogg, National Geographic Magazine, January, [illegible].

‡ See "[illegible] in America," by [illegible], National Geographic Magazine, December, [illegible].

[illegible]

Angry Waters, Whipped by Hurricane Winds, Topple Beach-side Homes at Nags Head

[illegible]

[illegible] Virginia [illegible] by others to be associated with the "Battle of Kilmarnock" [illegible] across the sound on the mainland and [illegible] to Roanoke [illegible] but were taught the [illegible]

[illegible] Nags Head, where wreckers were supposed to have [illegible] a lantern [illegible] light of a [illegible] It makes a good story [illegible] Nags Head to be [illegible] and [illegible] years of [illegible] with [illegible]

For ten miles south of Nags Head I drove [illegible] as our [illegible] in [illegible]

The [illegible] tracks like [illegible] in a [illegible] and [illegible] I was [illegible] because of its [illegible]

Going to Sea in an Automobile

Suddenly [illegible] There was [illegible] Beyond it [illegible] waters of Pamlico Sound [illegible] swiftly [illegible] There was no [illegible] sailing time. Some tire tracks disappeared into the water but in the [illegible]

there was no sign of where they emerged, if they ever did emerge. Instead of continuing down to [illegible] James's house.

Here, without warning, we [illegible], or [illegible] [illegible]. I was about to [illegible]. The [illegible] got a backward thrust which took us [illegible] water as a load [illegible] spray. I [illegible] [illegible] in the water. After half a [illegible] of channels we came to a marshy bank, and [illegible].

[illegible] near the Inlet [illegible] the [illegible] I saw the bank. The waves of the tide kept the duck [illegible] a few inches of water during the season and that, I [illegible], was normal.

A Haven for Birds

On the [illegible] we passed the [illegible] and black [illegible]. [illegible] as [illegible] and a large flock of cormorants, called "Cape [illegible]" [illegible] passed over the [illegible].

The [illegible] up [illegible] and [illegible] the [illegible] and dropped the [illegible]. [illegible] the [illegible] of the [illegible] and [illegible]. There was no road. [illegible] knew where he wanted to go and made his own [illegible] [illegible]. The sand [illegible] [illegible] and [illegible] the [illegible] [illegible], [illegible] over the sand but [illegible] [illegible].

[illegible] the [illegible] to the [illegible] I [illegible] [illegible] [illegible] enough [illegible] the [illegible]. I [illegible] [illegible] wheels but [illegible] [illegible] forward [illegible]. My [illegible] went deeper.

With the help of a passenger I [illegible] the [illegible] the [illegible] [illegible]. [illegible] were [illegible] jacked up on the [illegible] and [illegible] [illegible] [illegible] them.

After ten [illegible] my [illegible] were back on [illegible]. I [illegible] the [illegible] [illegible] from the [illegible], let my [illegible] [illegible] 20 to 15 pounds and, [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible] [illegible] [illegible] to the [illegible] I was [illegible].

I [illegible] the [illegible] Inlet Station and the [illegible] Island Station [illegible] [illegible]. The latter was [illegible] by [illegible].

[illegible] from its [illegible] [illegible], it was [illegible] [illegible] [illegible] [illegible] [illegible] and [illegible] the [illegible] of [illegible] [illegible] which [illegible] [illegible] [illegible] whenever some [illegible] [illegible]. Nearby is the [illegible] [illegible] [illegible] refuge where, with the [illegible] [illegible], thousands of laughing gulls [illegible].

Surprisingly, New Inlet had closed, and I [illegible] [illegible] [illegible] of the [illegible].

A few miles south I passed Chicamacomico Station, where I got some details of the hurricane of September 14, 1944, [illegible] which I had been hearing all over the coast. With the barometer down to [illegible] and [illegible] winds blowing, the sea rose and poured completely across the reef, piling up water in Pamlico Sound and flooding the mainland.

Suddenly the wind reversed [illegible] [illegible] with [illegible] of the storm center [illegible] [illegible]. [illegible] from the opposite direction, and the piled-up water from the sound turned back and swept across the reef, [illegible] the [illegible] [illegible] between the ocean.

Many houses came adrift in the nearby villages of Rodanthe and Avon, but thanks to quick action by Coast Guardsmen and fishermen, there was no loss of life.

Out at sea it was a different story. Two Coast Guard cutters, *Jackson* and *Bedloe*, were convoying a torpedoed ship northward. Mountainous seas laid them over on their beam ends, and they foundered.

After drifting in life belts and on rafts in shark-infested waters for more than 50 hours, survivors were picked up by Coast Guard air and sea units. Forty-seven officers and men lost their lives, 27 dying on the second night. In this rescue work the motor lifeboat from the Oregon Inlet Station did yeoman service.*

Thrice-accursed Spot

Ten miles farther on I reached a spot which is thrice accursed. In the August hurricane of 1899, the [illegible] *Priscilla* drove ashore here. Battling with tremendous force, [illegible] [illegible] a line [illegible] [illegible] [illegible], but her crew was nevertheless rescued.

The [illegible] [illegible]. She started to go to pieces, [illegible] [illegible] [illegible] [illegible] and [illegible]. The passengers [illegible] of the [illegible] [illegible] were caught by [illegible] the [illegible] and [illegible] [illegible] [illegible] [illegible] [illegible] over the side. [illegible] [illegible] [illegible] in two and [illegible] overboard. [illegible] [illegible] [illegible] with [illegible] [illegible] [illegible] [illegible].

[illegible] [illegible] [illegible] [illegible] to [illegible] [illegible] [illegible], [illegible] [illegible] within [illegible] of the ship. Mate and [illegible] [illegible] [illegible] [illegible] [illegible] the sea with [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] into the [illegible] [illegible] filled with

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* See "[illegible] with the [illegible] Coast Guard," by F. [illegible] Colton, National Geographic Magazine, May, [illegible].

[illegible] and in some cases saved three men. Captain [illegible] of Little Kinnakeet Station nearby had his [illegible].

This was not uncommon. The next day the barkentine *Priscilla* came ashore there. Four men were lost, but Surfman Rasmus S. Midgett of Gull Shoal station, on regular patrol and with the sea up to his saddle girth, went into the surf and single-handed saved ten persons.

That was still not enough. In the 1933 hurricane the [illegible] schooner *G. A. Kohler* was driven ashore at this same spot, but the water was so high that she rode far up on the beach. Nine crew members and a dog were taken safely ashore by breeches buoy. Captain [illegible], who had [illegible] in the [illegible] *Kohler* for many years, [illegible] took part in the *Kohler* rescue.

The hero of the *Priscilla* wreck, Rasmus Midgett, was a [illegible] one of the rest. The history of the Coast Guard and the old Lifesaving Service is inseparably linked with the name Midgett.

When Keeper John Allen Midgett and [illegible] in 1918 for the rescue of the British tanker *Mirlo*, the crew were all of the Midgett family: Keeper John, Arthur, Clarence, Zion, Leroy, and Lee O'Neal, whose mother was a Midgett. [illegible] before [illegible] was [illegible] that [illegible] all over the [illegible], where they [illegible] for [illegible] operations.

Several times while I was at Cape Hatteras Light the wind was blowing, the sea was rising, and the beach was steep and wet. I [illegible], however, and breathless [illegible] first [illegible] and [illegible] to make my [illegible].

Soldiers of the Sand

Hatteras Light was [illegible] after the Government had given it up for lost and built a new tower inland. The water had come in nearly [illegible] yards since [illegible], threatening the light. Brush fences caught sand, and sea oats were planted in it. The line has been [illegible] and now the light is out of danger. A lowly grass did what engineers and steel could not.

There has been constant warfare on the coast between the sea and the weather grasses of the sand. [illegible] the grasses were victorious. They built the barrier dunes behind which the forests of Hatteras grew.

Man has [illegible] a [illegible]. He cut the trees, and [illegible] and [illegible] the sand grasses. [illegible] the northern forest of Hatteras and [illegible] by the sea [illegible]. [illegible] to [illegible] the sea [illegible] and is [illegible].

[illegible] grasses each [illegible] sand grasses [illegible] to the [illegible] grass [illegible] from the south [illegible] coming on from the south. They form a soil, [illegible] better than that. They force the wind to drop the sand, and as the sand rises each year [illegible] of the [illegible] keep pace with the rising sand. In the meantime their [illegible] the [illegible] width.

A [illegible] which covers the range of [illegible] from northern to southern horizons.

[illegible], the grasses [illegible] the [illegible] of the [illegible] and [illegible] the [illegible] it [illegible]. [illegible] grass [illegible] in [illegible] there was [illegible] the [illegible] hurricanes.

Buxton Woods were a pleasant change from the sand and sea of the beach. The wind was but a whisper in the tops of the pines and I drove past [illegible] the [illegible], [illegible], and grapevines which grow to the treetops. And I [illegible] its farthest south [illegible] from the south—the [illegible].

In 1937 the Government took steps to make Hatteras a national seashore recreational area. Then [illegible] the [illegible] oil [illegible] for oil. [illegible] test well [illegible] the [illegible] for making Hatteras into a national [illegible] being considered.

Humor on Hatteras

During the war a Coast Guard doctor ministered to the people of Buxton and the other villages up and down the coast. He delivered many babies and relieved much suffering. The residents were not [illegible] of the humor in the situation when he stepped out of his official station wagon to visit an expectant mother, for on the side of the vehicle was the sign "United States Coast Guard [illegible] Service"!

Beyond the woods I drove through the

From Great Sand Dunes to Red Water and Desert Wings: Four Ideas on Airplane

[illegible]

Battle's Breaks in Southern Virginia Beach Waters Landing Craft Charged Astride a Prewar Deals Before the War

Off the Beach at Cape Hatteras, Gravesend at Steps, the Author's Sea Experiments with a Rubber Life Raft and Grenades, Mother

Like a Starry Dower on a Country Road, the Author Bowed Circle on His Sons and Dangled Hickory

Ile Cupe – Iles x Sangé. Co mité Cross Marks the Unesco World Heritage Site – Aconcagua Continent

Warm Gulf Streams, Tides and Endless White Beaches Make the North Carolina Coast a Paradise for Saltwater Bathers

On Roanoke Island the Epic Story of Raleigh's Lost Colony Lives Again in Live Drama

[illegible]

"Leave Me a Penny, Will You?" Be Serious and Get Gone!" Shows Old Lens, the Philosopher-Beggar, as an Admiring Spectator

These Old Mariners Still Man a Lifeline to Vessels Wrecked Near Cuttyhunk Island

To the "Headbreaker" the Great Sand Lance Reef Yields Rich Treasures

[illegible] to the [illegible] of Hatteras [illegible]. It is a place of [illegible], fig trees, [illegible], and only a number of [illegible]. Off-shore around the wrecks like [illegible], [illegible] and other [illegible]. [illegible] the [illegible] bass [illegible] Hatteras [illegible]. A [illegible] ferry makes [illegible] trips across Pamlico Sound to Engelhard on the North Carolina mainland.

Across the inlet to the southwest I knew the [illegible] of [illegible] Island [illegible] and [illegible] water, for I knew the last [illegible] of [illegible] shallow water. They [illegible] the *Carroll A. Deering*, a three-master. With her table set for dinner, she sailed on the shoal in February, 1921, with no one aboard except a cat. The cat [illegible] to the Cape Hatteras Lifeboat Station, but the mystery is still unsolved.

On the southern end is the village of Ocracoke, the metropolis of the reef. It has a concrete street which served as former Naval Amphibious Training Base. Here Blackbeard lived between raids, and in Hatteras Inlet there is [illegible] of his [illegible] days. An Army Air Force photographer brought to light the [illegible] under water of the [illegible] of a pirate [illegible] wounds (page 340).

Driving the Dark Reef

On the return trip north, darkness overtook me at Oregon Inlet (Plate VIII). The wash was smooth as velvet and hard; there was no sensation of the speed of the car. There was nothing outside by which to judge speed or distance. The beams of my headlights seemed to be [illegible] into the stars and the [illegible] the [illegible] at night.

[illegible] the surf began [illegible] the speed. [illegible] and [illegible] I saw it [illegible] and [illegible] for the [illegible] early and the [illegible] which I knew [illegible].

I drove on, kept [illegible] checking my [illegible] to the tenth of a mile against the [illegible] I kept [illegible] was [illegible]. There was nothing else to tell me where I was. There was the curious feeling that I was [illegible]. [illegible] when he [illegible]. But when I turned the wheel I [illegible] of the waves [illegible] again.

Something was wrong. I [illegible] the beam of Currituck Beach Light [illegible] was too [illegible]. I [illegible] and [illegible] the possibility that I had somehow made a wide [illegible] in the wide wash and was headed south. I waited until my computations showed that I should be abreast of the light, then turned up over the crest of the beach [illegible].

The tower was there, all right, looming up dimly in the darkness. But it was dark. It was like a good Samaritan after many years of help to travelers, suddenly gone blind.

I returned to the wash and drove a few miles, [illegible] around for another look. The light was on. It had been but a temporary stoppage. I still did not feel quite so lonely.

Suddenly there were green eyes peering at me from the sea. I relaxed when the eyes became [illegible]. Further on I pulled up sharply as more green eyes faced me from [illegible] and [illegible] my way carefully through a herd of cattle [illegible] at the edge of the surf, [illegible] chewing their cuds. They were refugees from the insect-ridden marshes.

As I [illegible] False Cape, [illegible] wheeled in my lights, and [illegible] words in the [illegible] as if they [illegible] headlights. The seas were running higher now and the [illegible] of foam on the [illegible] wash was like a [illegible] of diamonds in the headlights.

Because the wash was narrowed by the advancing tide, I had to run partway up the beach as each wave came in and then follow it back to the harder sand. This, with the [illegible] head [illegible] I [illegible] Little Island Station gave the car the effect of a ship [illegible] in a quartering sea, and I was glad when I splashed through Rudee Inlet and was at Virginia Beach.

The lighted streets [illegible] my eyes. I [illegible] there would [illegible] of New and [illegible].

Cold Flame in the Night

Back at my cottage at Cape Henry I went to bed tired, but I did not sleep well. There seemed to be a [illegible] to my [illegible].

I awakened to see a [illegible] on my wall. Raising myself on my elbow I looked out, straight into a fantastic scene, at what might well have been a stage from Dante's *Inferno*,* or what, to my [illegible] eyes, was a [illegible] on which [illegible] waves were [illegible] upon a [illegible] beach. Each wave was capped with fire which [illegible] blue, and as it broke there was a [illegible] flash, bright enough [illegible] to read the fine print of a newspaper.

I [illegible] to [illegible] my [illegible] and [illegible].

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*See *The Inferno* [illegible], [illegible] by [illegible] Doré, published by the [illegible].

An "Improved Road" on Cape Hatteras!

[illegible]

[illegible] clothes off of us, grown [illegible] and [illegible] down in the water.

When we got there it was no longer [illegible] instead, we were in a fantastic [illegible] pale [illegible] light.

Entranced, we plunged into the water. When we arose we were [illegible] with the water running down our [illegible]

On the wet sand [illegible] footprints [illegible] against the [illegible] of the [illegible]

Blue Crabs with "Headlights"

When we [illegible] the water [illegible] phosphorescent. [illegible] the water at the [illegible] and [illegible] the [illegible] blue [illegible]

[illegible] equipped with headlights [illegible] and [illegible] they [illegible] light.[*]

The [illegible] this strange water, and [illegible]

In his simple [illegible] Jerry, the [illegible] expert [illegible] The [illegible]

At last [illegible] we went back to [illegible] we had [illegible]

The cause of [illegible] fire was the [illegible] in the water of [illegible] plankton organisms. Such [illegible] are not [illegible] waters, but I have never seen so bright a [illegible]

Something like [illegible] at Santa Cruz, California, and [illegible] at Marshfield [illegible] Oregon. [illegible] of phosphorescence are [illegible] occurrence.[†]

The [illegible] sand [illegible] had [illegible] with [illegible]

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[*] See "[illegible]" by William Crowder, National Geographic Magazine, [illegible]

[†] See "[illegible] of the [illegible]" by William Crowder, National Geographic Magazine, [illegible]

Indian Life Before the Colonists Came

By [illegible]

[illegible] Indian villages [illegible] Colonies [illegible] history [illegible]

The artists were [illegible] Moore [illegible] Mountaineer John White [illegible] Moore in 1585 [illegible] French Huguenot colony in South Florida. White [illegible] Sir Walter Raleigh's planned [illegible] Virginia in 1585, 1587 and 1590.

Each was [illegible] to copy and [illegible] whole process. The results appear [illegible] pictures recorded in [illegible] another picture would affect the world today.

Le Moyne's New World [illegible] on September 24, 1565. [illegible] in Southern [illegible] in Florida [illegible] discovery by [illegible] or less in 1513 and [illegible] to Florida [illegible] the French [illegible] Fort Caroline and [illegible] most of the [illegible].

With a few [illegible] Le Moyne escaped [illegible] French [illegible] Spanish [illegible] Spaniards. White [illegible] of the [illegible] in France. Le Moyne later [illegible] in France, where he was [illegible] by Raleigh.

Indian Scenes in Water Colors

Le Moyne was not located [illegible] 1587, when Raleigh [illegible] Indian [illegible] Colonies [illegible] the French [illegible] in Florida. Holding [illegible] information, [illegible] Indian [illegible] that the Indians working [illegible] during the [illegible] following the [illegible] New World [illegible] of water-color paintings [illegible] Indian life.

News of Le Moyne's [illegible] reached the [illegible] of Theodore de Bry, a Flemish goldsmith, engraver and publisher who [illegible] from his [illegible] Liege to Strasbourg and [illegible] to escape religious persecution. De Bry [illegible] Le Moyne's paintings, planning [illegible] to publish a [illegible] of Huguenot [illegible]. The artist [illegible] and De Bry returned to Germany.

A year later De Bry went back to London and brought [illegible] with him. Le Moyne died in 1588, and [illegible] the paintings of the Florida [illegible].

On an island in Hudson's Bay [illegible] interest was in English [illegible] the New World. In the [illegible] Le Moyne's pictures and [illegible] were presented to John White, the Roanoke [illegible].

When [illegible] America with Raleigh's [illegible] expedition in 1585, he returned to England [illegible] on Roanoke Island [illegible] number of years, and of which later became North Carolina. He was [illegible] again as governor, in 1587, [illegible] to Roanoke in order to [illegible] the potential resources and help [illegible] Raleigh's [illegible] in England [illegible] in America.

Prevented by [illegible] from returning [illegible] supplies, he was [illegible] ordered away. He was [illegible] to leave more than a hundred colonists [illegible] in the wilderness and his new grandchild, Virginia Dare, the first English child born in the New World. Not [illegible] White made his [illegible] to America.

Mystery of the "Lost Colony"

When he [illegible] Roanoke Island [illegible] found [illegible] the single word "Croatoan" [illegible] on a tree. White attempted to [illegible] the colonists to [illegible] Croatoan, [illegible] Indian [illegible] of the [illegible] Island.

Most fascinating to Le Moyne and White were the [illegible] of the Indians [illegible]. At no small risk [illegible] among the Indians [illegible] attempts to [illegible] a [illegible] of repetition of New World [illegible] the civilization of the Old World. Among [illegible] the [illegible] [illegible].

Certain Indian customs [illegible] to be a [illegible] to Europe [illegible] to describe [illegible] aboriginal [illegible] the [illegible].

Describing a [illegible] ceremony, [illegible] a [illegible] in the Virginia [illegible] White reported that [illegible] the [illegible] "suspended [illegible] in the midst of the [illegible] were [illegible] taken away." He [illegible] that [illegible] which [illegible] [illegible] strange [illegible] and [illegible] observers. White [illegible].

A Bare Life of the Indians

Indians [illegible] the Southeast [illegible] life with its homes and [illegible] were [illegible] by White [illegible] than those [illegible] the [illegible].

Florida (Plate III). These two scenes depict many aspects of Indian life: [illegible] hunting, [illegible], and appear [illegible] [illegible] [illegible] obtaining water from [illegible] [illegible] of [illegible].

Visiting [illegible], a village near Roanoke Island, White was attracted by the way the women there carried their children (Plate IX). "For one woman," he recorded, "their children on their [illegible] [illegible] [illegible] [illegible] by the right hand [illegible] on her back, holding the left thighe in their left arme." Here the artist erred, for in the drawing, [illegible] and [illegible] [illegible] the child [illegible] by the left hand and right [illegible].

"When they go to battle they paint their bodies in the most terrible manner that they can devise." White saw [illegible] of the [illegible] of [illegible] of Virginia (Plate V). They carry a [illegible] made of small rushes holding their bows ready bent in one hand and an arrow in the other, ready to defend themselves.

Le Moyne recorded the existence of [illegible] [illegible] in the Indian language Apalatci, [illegible] [illegible] from Fort Caroline, [illegible] [illegible] [illegible] gold, silver, and brass mixed together. Accordingly, the natives dig [illegible] [illegible] [illegible] [illegible] the sand [illegible] down by the current [illegible] [illegible] [illegible] they collect it out (Plate VI) and carry it away [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]."

The Virginia Indians' method of [illegible] [illegible] attracted White's [illegible] [illegible] (Plate VII). "[illegible] [illegible] [illegible] [illegible]," he recorded, "they [illegible] how to make them as [illegible], [illegible] [illegible] when [illegible] [illegible] in their [illegible] [illegible] to fish with [illegible] [illegible]."

An Example for White Men

Le Moyne gave [illegible] [illegible] the Florida Indians' [illegible] storing their crops in [illegible] (Plate VIII). "[illegible] [illegible] of the provisions [illegible], [illegible] [illegible] [illegible]. Indeed," Le Moyne observed, "[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] among them and [illegible] the [illegible] of man."

Le Moyne's attention to detail is evident in his painting of an Indian chief [illegible] tattooed and bedecked with feathers and [illegible] ornaments, [illegible] [illegible] [illegible], and with other [illegible] and [illegible] [illegible] [illegible] (Plate XI). [illegible] Florida scene, however, is apparently [illegible] to a [illegible] [illegible], for [illegible] [illegible] [illegible] [illegible] [illegible] (Plate XIII).

The Virginia Algonquians' habit of cooking and eating their fish in one place after catching them, as compared with the Florida Indians' [illegible] [illegible] of [illegible] [illegible] or [illegible] [illegible], was noted by White (Plate X).

White [illegible] the [illegible] [illegible] in which they cooked [illegible] (Plate XI) [illegible] large [illegible] [illegible] [illegible] with [illegible] [illegible] [illegible]. Of the Indians' moderate eating habits he said: "I would to God we would follow their example. For wee should bee free from many kinds of diseases which wee fall into by sumptuous and unseasonable banketts, continually devising new sawces, and provocation of gluttonnye to satisfie our unsatiable appetite."

Conjurers, or medicine men (Plate XII), were important personages in early American tribal life, and the Indians White recorded "give great credit to their speeche which oftentymes they finde to bee true."

An Early American Festival

One of White's most elaborate works was his interpretation of a festival scene (Plates XIV, XV), in which men and women [illegible] [illegible] [illegible] [illegible] [illegible] surrounded by seven [illegible] carved posts [illegible] [illegible] the [illegible] Virgins [illegible] [illegible] dancing about the posts. These [illegible] [illegible] were related to [illegible] [illegible] of the crops [illegible].

Beside the [illegible] bodies of their departed chiefs (Plate XVI) White wrote "the Indians [illegible] their god Kiwasa . . . for they are persuaded that the same doth kepe the dead bodies of their chiefe lordes that nothinge may hurt them." [illegible] [illegible] "[illegible] [illegible] [illegible] [illegible] [illegible] by nature to [illegible] [illegible] [illegible] [illegible] [illegible]."

In 1590 De Bry published in Latin, [illegible], [illegible] [illegible] Harriot's *Briefe and True Report* [illegible] illustrated by [illegible] engravings from White's original Virginia water colors. The [illegible] volume, *Brevis Narratio*, with engravings of Le Moyne paintings, appeared a year later. These two works launched De Bry's great publishing project, *Grands et Petits Voyages*.

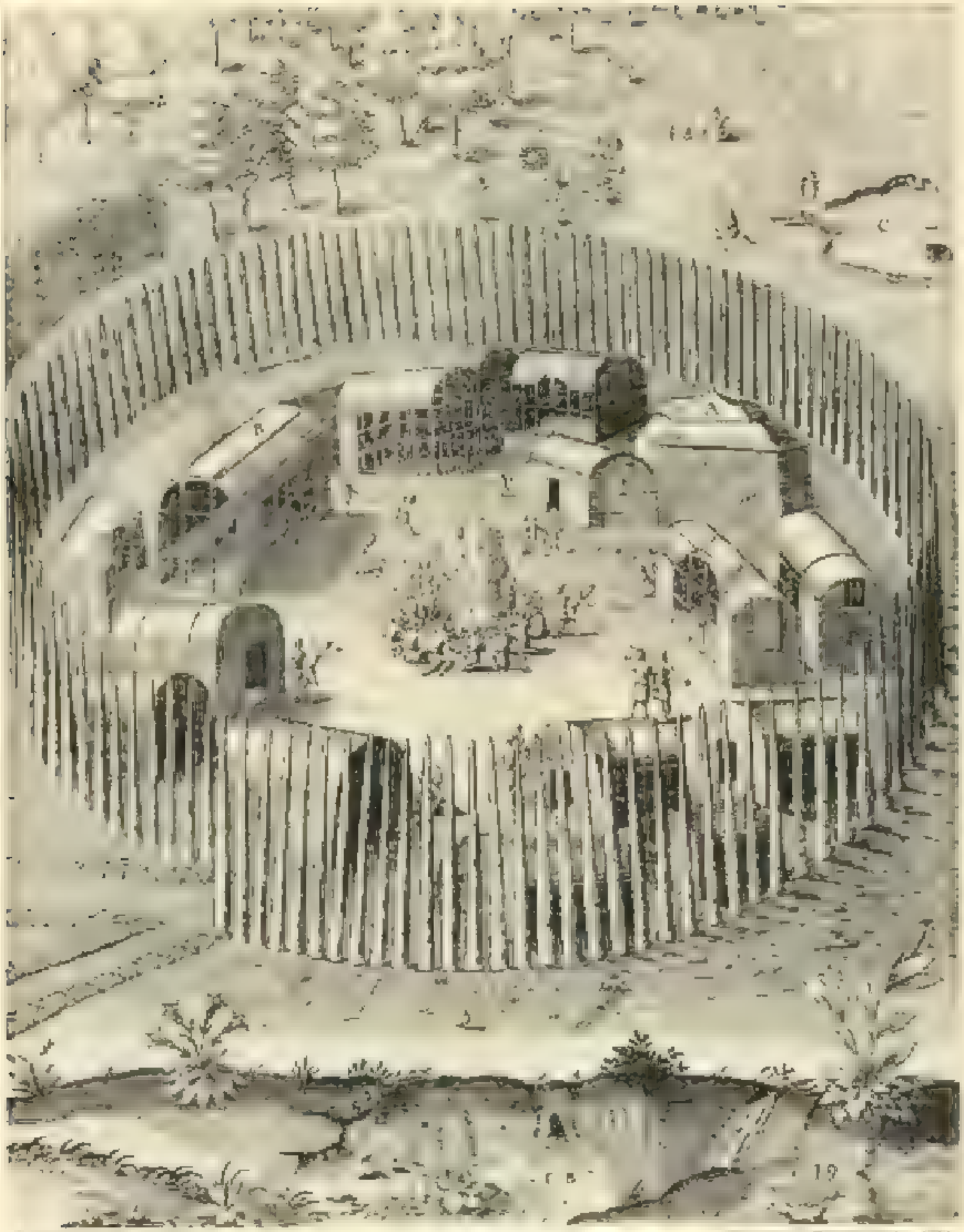
The [illegible] [illegible] [illegible] White and [illegible] after Le Moyne reproduced on the following [illegible] pages of The National Geographic Magazine have been [illegible] from *Admiranda Narratio* and *Brevis Narratio* in the Rare Books Division of the Library of Congress, Washington, D. C.

The Lessing J. Rosenwald Collection in the Library [illegible] one of the few copies of De Bry's 1590 English version on Harriot.

"When They Be Returned from the Wars . They Make Merrie about the Fyer"

"Houses of the Towns of Secota Have Gardens . . . Wherein Groweth Tobacco" (E)

In this large round carved gourd (Plate XIV, XV) found in the Stone Street (D), stalks of corn are seen to grow. Crouching in a hut (F), a woodman makes cardinal cross and prays to [illegible] trees and beasts away from [illegible] space was left between [illegible] the growth of another. Tobacco grow in patches (G). From the roof [illegible] villagers [illegible]



"The Town of Pomeiock . . . Compassed About with Poles Stacke Faste in the Grownde"

[illegible]

"Their Manner of Carriage, Their Children and Attire of the Cheville Ladies of the Towne of Dasamonguepeuc"

"Werowans or Great Leades of Virginia Wear the Skinne of Some Beaste [illegible] the Tayle Hangeth Down Behynde"

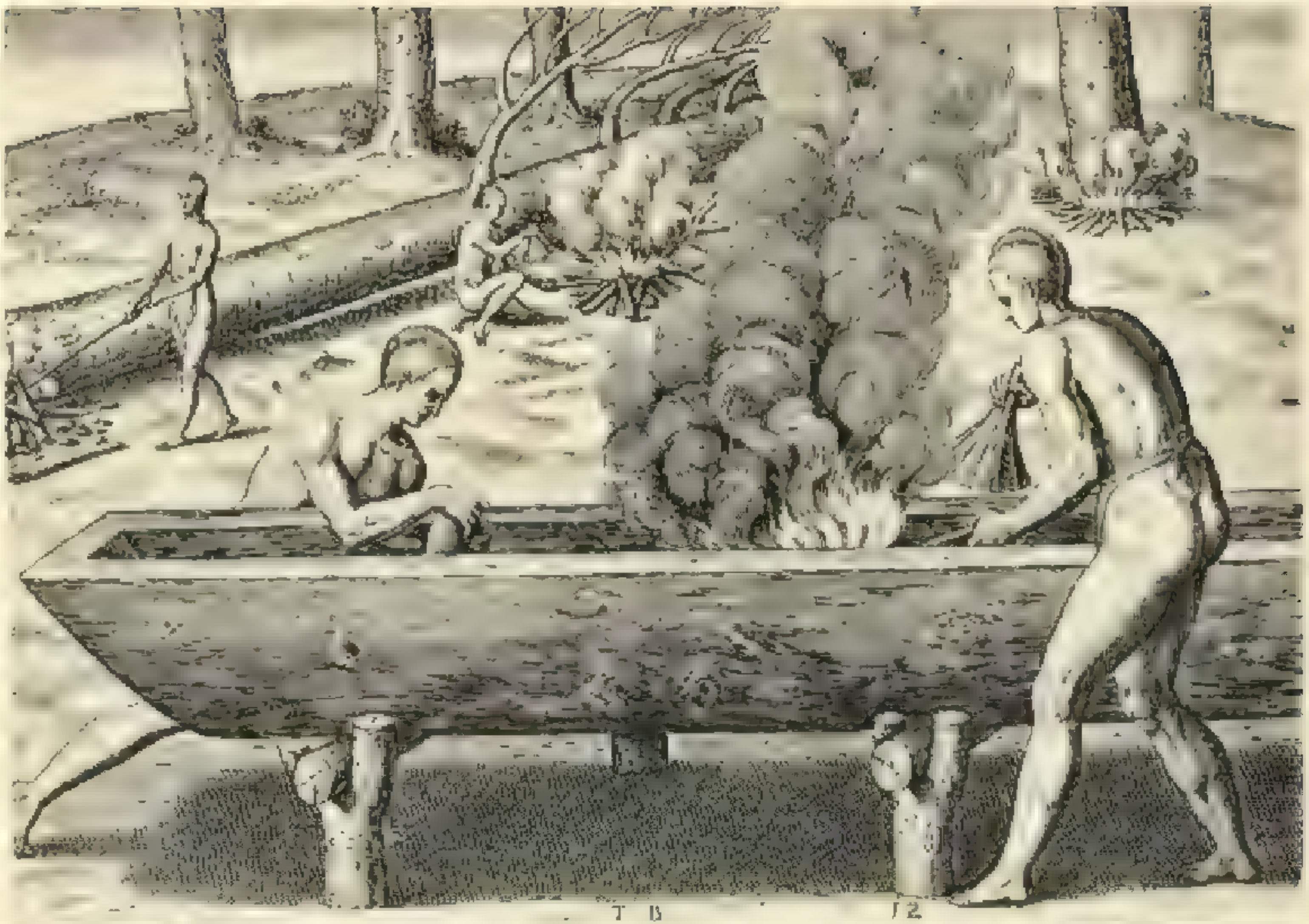
[illegible] Wild Fowl [illegible] Deeres hunted [illegible]

Natural History Society

Engraved by Theodore de Bry, 1591

"Their Manner of Coloetynge Golde in Streames Rummyage from the Apalatey Appalachian Mountaynes"

The artist's exaggerated quantities of "silver and brass" the colonists expected. The Indians pocketed eastern seaboard with Europeans down the River of May (St. Johns) to trade with the Spaniards in Florida.



"The Maanner of Makinge Their Boates in Virginia Is Verye Wonderfull"

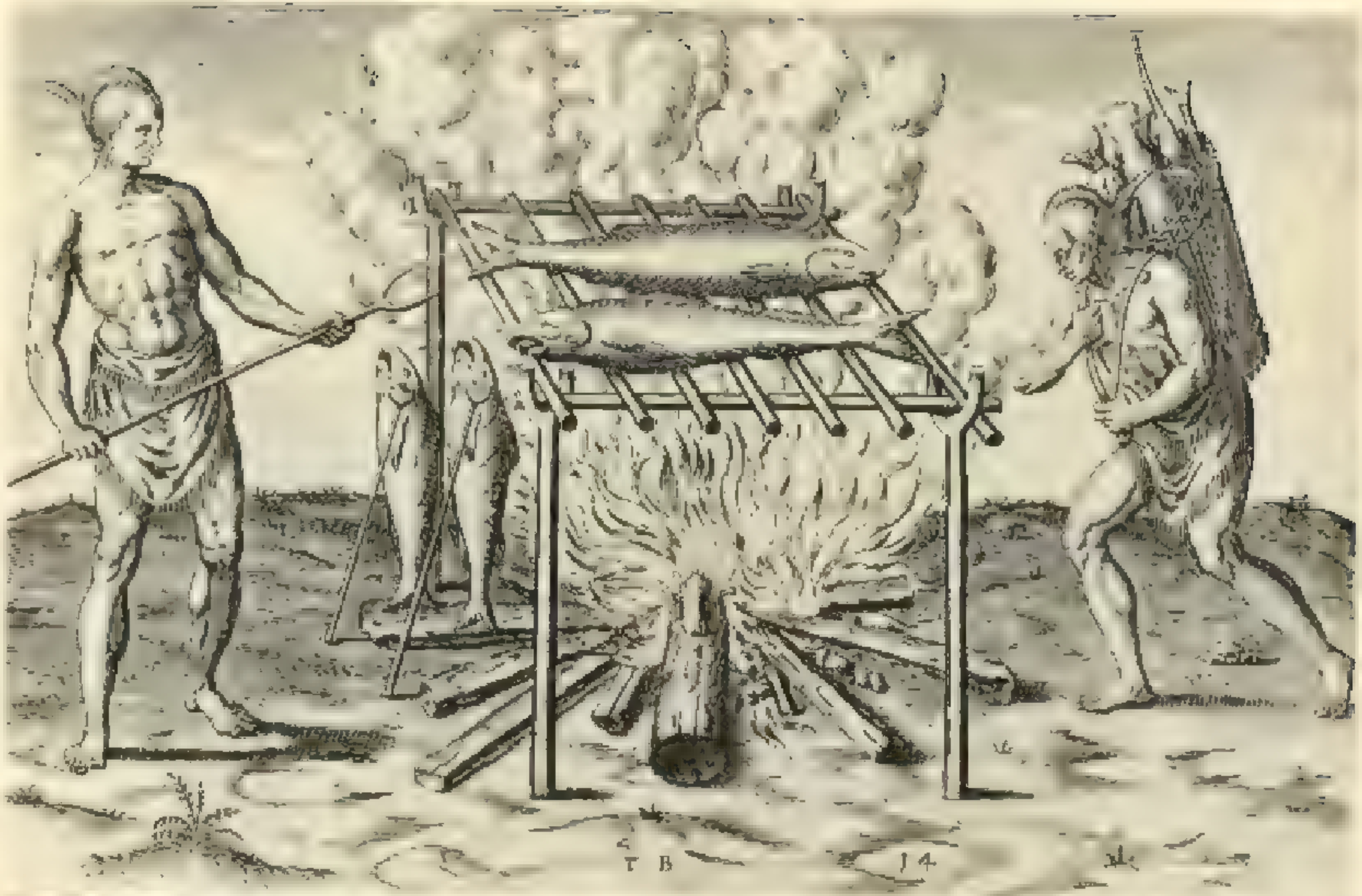
Indians felled trees by burning low fires on them in the woods (upper right), then hauled off logs and branches (center background). Lacking iron tools, they hollowed out the trunks by burning and scraping, use with sharp shells.

"Industry of the Floridians in Storeage Their Croppes in the Publicke Granarie"

Today a very narrow strip of the New World market [illegible] will [illegible] it to storage houses built of earth and stone. Some [illegible] which were erected in shade trees to protect their contents from the sun [illegible]

"The Cirette Applied to by Women Whose Husbands Have Died in Wars or by Disease"

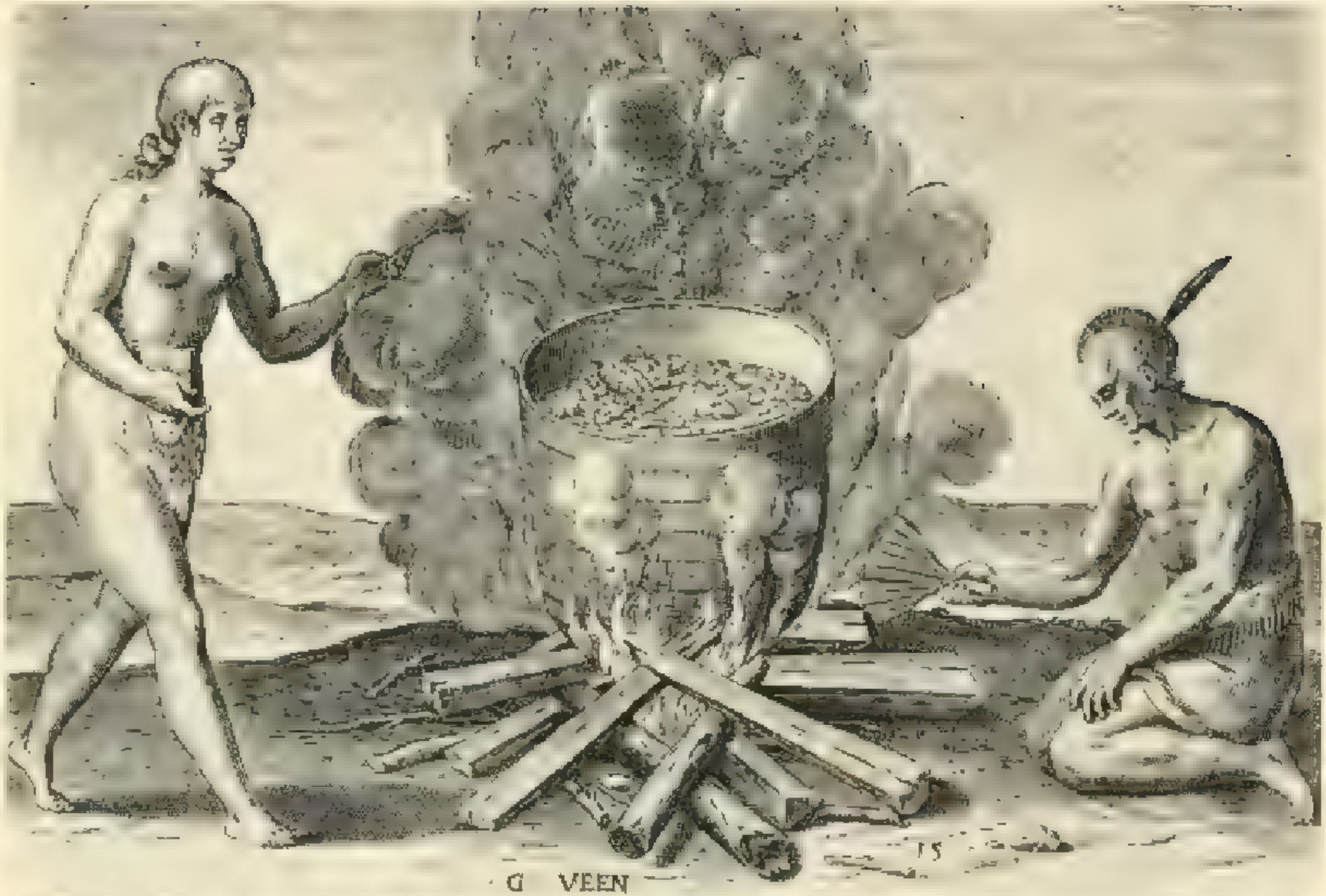
[illegible]



© National Geographic Society

"Broylinge Their Fishe over the Flame . . . They Take Good Heed that They Bee Not Burnt"

Two [illegible] circle [illegible] wooden grill supported by [illegible], two more are cooked beside the [illegible] the basket [illegible] a [illegible] and a [illegible] Virginia Indians [illegible] at [illegible] those of Florida used them. De Bry [illegible]



"Their Seetheynge of Their Meate in Earthen Pottes"

From [illegible] "as in a gallimaufry or olla podrida [illegible] Spanish [illegible]." In its [illegible] and [illegible] that the English might well emulate the Frenchmen [illegible] and thus "the [illegible] country [illegible] of [illegible]."

"The Conquerors Use Strange Gestures . . . and Be Verse Punctuse with Deeds"

"Their Manner of Killing Crocodiles"

[illegible]

"At Their Great and Solemn Feasts They Dance and Sing"

Several times a year members of the Virginia Algonquin tribes gathered [illegible] to spend hours singing and dancing in a circle before the John White [illegible] group that [illegible] the festival.

Some [illegible] of the Indians [illegible] as they [illegible] with parts of [illegible] and [illegible] were either [illegible] to [illegible] the [illegible] of [illegible] [illegible] where. The [illegible] appeared in the [illegible] to the town in Secoton [illegible].

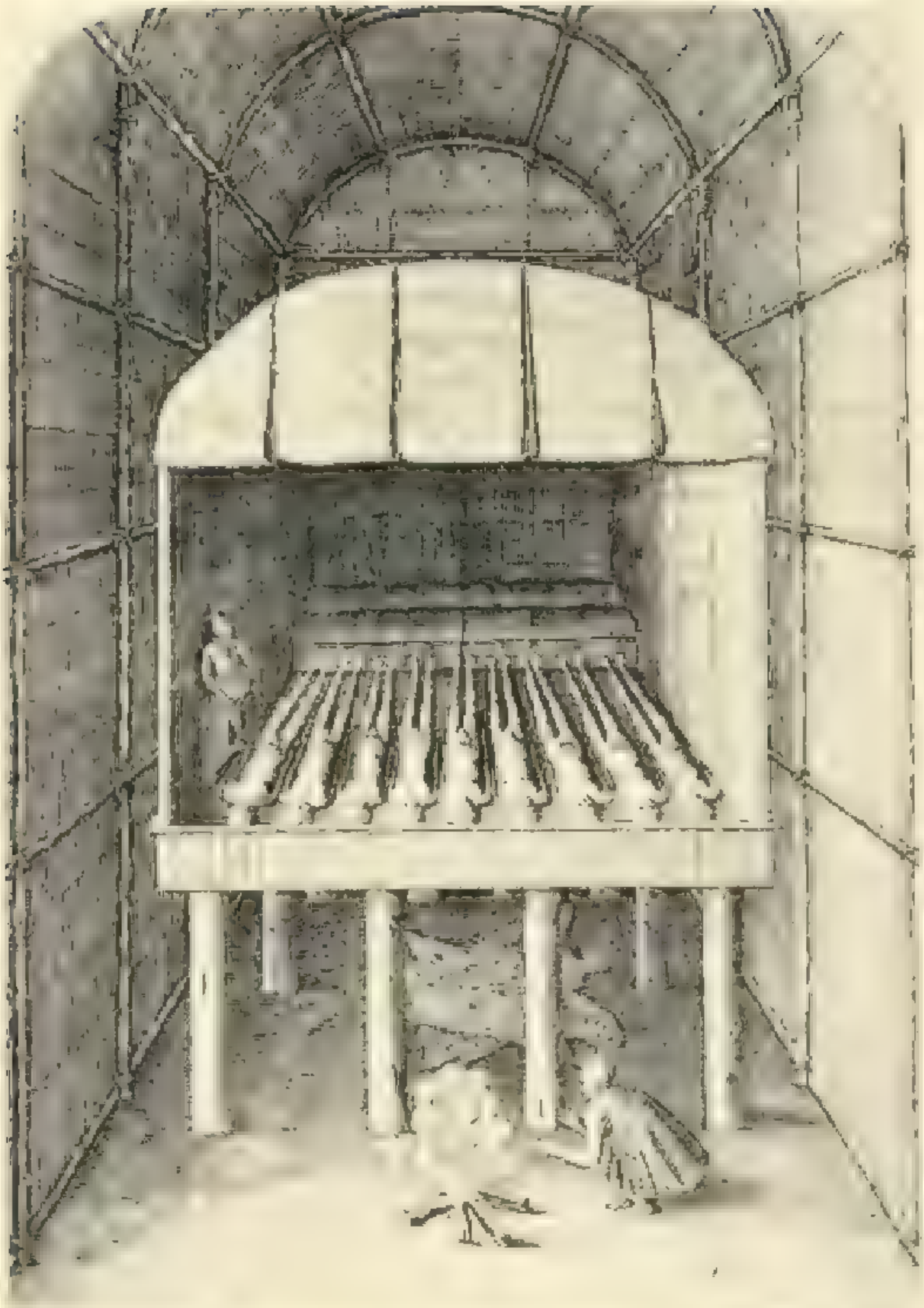
The festivities began [illegible] with the men "adorned in the most strange fashion that they can devise having [illegible] masks on the faces to answer to what else they see." The dry [illegible] of seeds or pebbles [illegible] accompanied their singing and dancing. When [illegible] dropped out of the circle because of exhaustion [illegible] took their places.

In the center of the ring [illegible] by the carved posts stood [illegible] of the [illegible] Virginia of the [illegible] who embraced each other and turned around and around as the dance proceeded. In [illegible] the [illegible] also played important parts in crop [illegible].

To White the carved heads on the posts resembled those of wooden [illegible]. They are [illegible] to represent many deities.

[illegible]

[illegible] 1585



"The Tombes of the Weroans or Chiffe Lordes"

Here John White graphically depicts the Indians' methods of embalming their deceased chieftains and supposed even after death. He represented how a leader's body was eviscerated and smoked from the [illegible] fire. Both the other and body in the sun. The [illegible] was placed on a wooden [illegible] and was wrapped in mats and placed in the tomb. The priests kept constant vigil preying for the souls of the departed.

Born Hunters, the Bird Dogs

By Roland Kilbon

THE squirrel, scrambling up the hillside, paused. In front of him, on the sunny side of a clump of [illegible] was the setter's [illegible] point. A moment before, a pheasant had been feeding there. The scent of game came heavy [illegible].

A few moments' caution in which his eager tail flicked faster than ever, the dog plunged into the thicket where the bird had sought refuge at the first sign of danger.

In an instant, with much squawking and noisy beating wings, the pheasant broke into the air. The dog, at the far side of the brush, [illegible] let it fly. There was a shot and the bird fluttered down.

At the command of the hunter the dog was off like a shot toward the point of fall. In a few moments he was back, sitting before his master, proudly holding up for the bird to be taken from his mouth.

Man and Dog an Age-old Team

Here was demonstrated with 20th-century equipment the joint effort which brought about an essential partnership in the animal kingdom—that of man and dog.

Originally, the dog was a larger and more wolf-like creature. The man, possibly clad in skins of wild beasts, may have used a bow and arrow, a club or a sling. But the two were working together to provide something for the pot.

Then, as now, the dog was using its superior sense of smell to locate and flush the game. The man contributed his weapons to bring down the quarry, which the dog alone could not do. In partnership, they assisted each other as a team.

In the primitive period when man and dog began working together, all were hunters. Today the number of dogs trained to hunt forms only a small proportion of the canine population.

Man, to suit his tastes and his mode of living, has evolved many breeds to a size which would have doomed them to speedy extinction in the days when an animal was the prey of other beasts or more crafty creatures.

For all the tremendous changes which have taken place over the centuries, one fundamental factor in the original partnership remains. This is the satisfaction which both man and dog draw from their ability to work together.

It is well for poets and essayists to proclaim the comfort that comes from a cold nose thrust against one's hand when one is uneasy or discouraged. But any man who really has worked with his dog will testify that the resulting gratification for both is the satisfaction of [illegible] cooperation [illegible].

Both man and dog are elated at the successful completion of any joint project, be it the performance of some simple, basic trick or the most taxing round of tests at a field trial.

This fact explains the tremendous growth of obedience trials in recent years. In these, dogs begin with such elementary things as learning to walk at heel and sit when their handlers stop. They carry on through jumping and retrieving to such advanced tests as scent discrimination and, finally, tracking.

Nowadays there is scarcely a dog show in this country to which obedience trials do not form an important phase. Usually they can be found by going to those rings around which the crowds gather thickest.

Obedience is being widely sought by some groups and, in large cities, by humane organizations who realize that the better trained a dog becomes the more acceptable he will be as a neighbor. This wide participation is [illegible] awakening of [illegible] responsibility on the part of dog owners. It further [illegible] brings into play the best teamwork of man and dog.

Instinct Survives Breeding Changes

When Glenmere's Betsy, UD (that UD stands for "utility dog," the highest degree in our obedience [illegible]) [illegible] a brace and the exercise completed, [illegible] her handler [illegible], she exhibits the satisfaction which her ancestors felt ages ago when one of them brought to hand the game his master would share with him.

Betsy is a little toy Pomeranian, bred so far down in size from her progenitors which roamed European forests that she would be lost in the hunting field. The fact that she has been reduced to the stature and status of a toy has not caused [illegible] desire to be man's partner.

But on the hunting field the original relationship most clearly survives. There the dog seeks out game for the hunter and brings it back.

One has only to watch the pride of any gun dog delivering a bird to know that here is the peak of canine satisfaction.

There are rich rewards, too, for the man who guides a young dog through the intricacies of field training.

[illegible]

A Good Bird Dog Honors His Bracemate's Point

[illegible] [illegible]

On the day when [illegible] [illegible] [illegible] and [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] the average [illegible].

Field trials provide a competitive outlet for this relationship. [illegible] also brought a vast stock for breeding.

In the wild state [illegible] the hunting instinct [illegible] [illegible] dogs has been little [illegible] by the course of civilization.

When a man tells you his dog has [illegible] [illegible] [illegible] [illegible] Mary Montrose [illegible] [illegible] Rex, you know that dog was bred to hunt.

It may never [illegible] the [illegible] of those [illegible] [illegible], [illegible] two dogs [illegible] [illegible] [illegible] [illegible] [illegible] after [illegible].

The Weimaraner, Born to Hunt

The extent to which the hunting instinct is [illegible] in a dog is illustrated by the experience of a man in New England who acquired a Weimaraner pup. This German breed, of late [illegible] and [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] has been brought to this country.

The New Englander was prepared to take [illegible] [illegible] [illegible] of [illegible] the [illegible] [illegible] the [illegible] of the [illegible]. However [illegible] [illegible] attention to the [illegible] [illegible] and [illegible] tried to take him.

Writing in a recent issue of the news letter issued by the Weimaraner Club of America, the owner recounted [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] the dog. He did not [illegible] [illegible] the [illegible] and [illegible] [illegible] and then [illegible] to [illegible] [illegible] [illegible] [illegible] when [illegible] explored [illegible] birds [illegible] on the [illegible] [illegible] the woodcock season.

They had not gone 75 yards before the dog came to a rigid point. The [illegible] hunter [illegible] that [illegible] had [illegible] the Weimaraner [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

Just to see what the young dog would do, he [illegible] [illegible] "Go get the dead bird!"

The [illegible] [illegible] the scent [illegible] the bird [illegible] pointed again. [illegible] [illegible] his [illegible] [illegible] [illegible] he [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] and held up the game to be taken.

In His Leap, the Labrador Retriever Shows Canine Determination at Its Peak

The [illegible] purpose. He is [illegible]

In the partridge season which followed, the dog had another chance to demonstrate that this was no illusion. With no further [illegible] he turned out to be [illegible] retriever.

He never [illegible] again, but neither did he ever get over the habit of stripping feathers and [illegible] a few times a bird in mouth, before coming in to [illegible] the [illegible].

This eccentricity would certainly count against him at a trial, but his owner wouldn't swap him for all the field champions in existence. They have worked out their own partnership [illegible].

Trained Dogs Aid Conservation

Field trials serve an important function aside from demonstrating hunting qualities of the participants. It is their value as a school in which all sportsmen can learn what part a trained field bird dog plays in conservation.

The man with a good dog can fill his bag with the allotted number of [illegible] birds more quickly than the man who lacks the cooperation of a canine partner. Furthermore, he does this without leaving behind a number of crippled birds.

On the basis of questionnaires sent to duck hunters, the American Field reports that [illegible] ducks were crippled and lost in a season during which about [illegible] were brought to bag. Hunters were almost unanimous in agreeing that the use of properly trained retrievers would lower that figure tremendously.

All lovers of game [illegible] the same [illegible] that conservationists wish there were some practical means by which every hunter could be required to take a well-behaved dog into the field with him.

Such a time is unlikely ever to come true. But as field trials continue to spread, more and more sportsmen see what the well-schooled shooting dog can do. The number of [illegible] hunting partnerships increases.

[illegible] these dogs [illegible] to find the birds, to get them into the air, and to bring them back after the hunter has brought them down.

While the average [illegible] does all of these special [illegible] parts of the job for different breeds. In the pointing breeds [illegible]

"Go Find Him, Boy!" Peerless B Guy Breaks Away at Command to Hare in an Orange County, New York, Field Trial

Hoss (above), Judges 5 Whitebridge Wally as Much at Home on Land as in Water Guarantees a Quick Retrieve

Is He a Pointer or a Retriever?

[illegible] Vermont [illegible] the United States [illegible]

[illegible] stooping [illegible] with [illegible]

In the [illegible] retrievers [illegible] whose [illegible] is [illegible] the ability to bring back the [illegible] rather than [illegible] it is emphasized. Spaniels are expected to [illegible] the birds, get them off the ground, [illegible] after they have [illegible]

Trials for the [illegible] sponsored [illegible] amount. Last year approximately [illegible] were held, with a total of [illegible] starters. The [illegible] the trials held [illegible] grounds [illegible] where dogs which [illegible] in the winter [illegible] in Mississippi [illegible] Tennessee [illegible] the [illegible] of the season [illegible]

The pointer and setter [illegible] what amounts to a [illegible] working [illegible] dogs, the National [illegible] Grand Junction, Tennessee, [illegible]

Many prominent trainers [illegible] in Manitoba [illegible] with their [illegible] dogs, which are [illegible] and [illegible]

Pheasants [illegible] Hungarian partridges [illegible] still prevalent [illegible] rows, has rendered [illegible] their [illegible] section.

Field trials have their [illegible] too, [illegible] football [illegible] get a chance to [illegible] The average sportsman is [illegible] the [illegible] and the [illegible] qualities of [illegible] he will realize that [illegible] in the fields [illegible] would be as much out of place as [illegible] playing [illegible]

Such a [illegible] the National, [illegible] would prefer [illegible] at one of the [illegible] trials held in all parts of the country.

In the [illegible] trials [illegible]

events are called [illegible] [illegible] because, since they are not run on big pastures, [illegible] [illegible] [illegible] [illegible] [illegible] over the same ground. It is necessary to [illegible] [illegible]. If the [illegible] [illegible] the first dog down would have all the advantage and those [illegible] [illegible] would be [illegible] to find bird.

Dogs Work in Pairs

In [illegible] trials, regardless of [illegible] [illegible] [illegible] [illegible] [illegible] [illegible], it is customary to [illegible] the dogs in pairs, [illegible] to reduce the time required to give each dog a fair chance and to lessen the [illegible] [illegible] [illegible].

The contestants [illegible] [illegible] [illegible] through [illegible] [illegible] [illegible] where the judges can observe their [illegible] [illegible] and their [illegible] [illegible] [illegible] [illegible]. Then they are brought into the bird field where [illegible] [illegible] [illegible] [illegible].

[illegible] [illegible] is not without its [illegible]. The [illegible] [illegible] [illegible] [illegible] [illegible] to follow the judges [illegible] [illegible] [illegible] [illegible] to see the bird field and [illegible] [illegible]. [illegible] [illegible] the [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible] [illegible] to hold [illegible] [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] good [illegible] [illegible] when the handler [illegible] the [illegible] and [illegible] [illegible] (page [illegible]).

The [illegible] [illegible] of [illegible] [illegible] [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] of the [illegible] [illegible] dog [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] from the [illegible] [illegible] [illegible] [illegible] [illegible]. [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

[illegible] Express Proves He Has a Champion's Heart

[illegible]

[illegible] [illegible] [illegible] [illegible] [illegible] good bird dog is [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] and the [illegible] [illegible].

[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]. [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible] to [illegible] [illegible] [illegible] [illegible] the [illegible].

Holding Point Tests Steadiness

The [illegible] dog [illegible] the [illegible] [illegible] and [illegible] [illegible] point [illegible] [illegible] [illegible] [illegible], [illegible] [illegible] does not [illegible] [illegible] [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

his command from the judges to flush the bird, and then fires a blank pistol cartridge to test the dogs' steadiness to shot.

Since pointers and setters [illegible] as they might in a [illegible] field, [illegible] so large a course that the dogs can be put down in [illegible] without covering the same ground.

There the dogs may range far "before the eye of [illegible]," from the [illegible] judges and gallery following up. The dog may have to hold its point for some time so that steadiness and stamina as well as bird sense are severely tried.

Just how long a bird dog will hold a point has always been a moot question. I saw a [illegible] test at an informal trial out on Long Island. A setter, let out of her master's car for exercise, caught the scent of birds in a crate waiting to be turned out for planting.

At once she came to a point and refused to be distracted by the other dogs and the men moving about her.

At the [illegible] her owner let her stand for [illegible] minutes. She might have stood [illegible] all the evidence to the contrary. She [illegible] budged when her master decided that she had had enough and called her to him.

This setter was a nondescript animal. She looked as if moths had been having a field day in her coat and she would not have gotten a second look from a judge at a bench show, but there was no gainsaying her proficiency in her own sphere of competition.

There may be some truth in that old tale of the lost dog whose master months later found a skeleton of a dog pointing to a skeleton of a covey.

Standards of Field Trial and Bench

Present interest in hunting skill has widened a gap between field-trial followers and bench fanciers, especially in the pointing breeds. How these cover their ground and how they handle their birds, rather than how they measure up to a bench standard, are of main interest to the hunting fraternity.

This point of view was well exemplified by the personal [illegible] of a little English cocker spaniel, Dorothy Bess. Seemingly [illegible] much [illegible], [illegible] to anyone seeking an ideal specimen of her breed, she was a great [illegible] hunter.

[illegible] to follow the flight of her [illegible] [illegible] she would sit erect on her haunches [illegible] had flushed [illegible] until [illegible] On the command to fetch she would be off like a dart and [illegible] back with a cock pheasant [illegible].

One [illegible] who [illegible] her [illegible] of much [illegible] [illegible] when [illegible] "She'd [illegible] know what it was [illegible]. She's a [illegible] ever I saw one."

Bess has been gone for some years, but I can still see her in memory, with her stern quivering with excitement, her eyes fairly sparkling as she watched the flight of her bird.

Neither retriever nor spaniel trials are so common as those for the pointing varieties. There were 61 [illegible] trials for retrievers in 193[illegible], with a total of 1,[illegible] competitors, and 31 [illegible] spaniel trials with some 800 entrants.

One Award in National Championship

In some respects the retriever trials are the best organized of all. A national championship held early in December [illegible] the 20 dogs which have made the best showing in the open all-age stakes at licensed trials in all parts of the country.

There are no second- or third-place awards in this stake, and the dog which emerges the winner is officially adjudged the national champion retriever of the year.

The spaniel fanciers are moving in the same direction, and this December, for the first time, will hold a national championship stake in the Midwest [illegible] with [illegible] qualifications as those which now determine the retriever championship.

Trials for retrievers and spaniels differ from those for pointers and setters chiefly in the fact that at the former the birds are killed and the dogs are required to bring them to hand.

Another difference is that where pointers and setters are ranging far afield, going along [illegible] and freezing to a point when they find their quarry, the retrievers and spaniels are at all times [illegible] close [illegible].

The retriever is not asked to locate the game. His job is to bring it to hand after it has been knocked down. [illegible] he does not [illegible] handler [illegible] as a [illegible] retriever (page 3[illegible]).

In this category come the Chesapeake Bay, curly-coated, flat-coated, golden, and Labrador retrievers, and the Irish water spaniel (Plates IX, X, XII, XV and XVI).

Fanciers of the Weimaraner [illegible] that their breed belongs here, also, but the American Kennel Club has listed it as a pointing breed. As a result, the Weimaraners have

With Graceful Heads and English Setters, It's the Same Thing Coming

Camouflage, a Quail's Chief Defense, Fails When Keen-nosed English Setters Strike Its Scent

Pertinent Results of Genetics in Crossbreeding Heat with Closely Sweet and Superlative Storing Power

Gordon Setters Are as Hedged as Their Native Scottish Moors

[illegible]

'Handsome Is as Handsome Does.' Six Irish Setter Puppies

[illegible]

Friendly American Cockers, Smallest of the Sporting Spaniels, Are This Country's Most Popular Dogs

Stamina, Wealth and Abundant Energy Make English Springer Spaniels Ideal for Hunters in Rough Cover

[illegible]

Longer Legs Give the English Cocker an Edge over His American Cousin

Extra Inches Gives Mother the Welsh Springer an Advantage Afield

Irish and American Wolf—Spaniels Still an Extension for Wolf Coursing

Golden Retriever, Nineteen Months Old, Sitting up for Food | Photo by Stumpes

Siberian Husky Puppy, Eight Weeks Old, Playing with Its Mother | Photo by Stumpes

An English Nurse Rocks the Sedan Chair of Sitwell's Friend Orlando

Weatherbird Pasture Girl Ice Cream, Tables and Sun on Charred

Brewsters Sparrows, Ranges and Powerful, Are Found as with Pointers in New England and Frequent Canada

Germany Contributes a Novelty, the Weimaraner, and an Old Stand-by, the Short-haired Pointer

Equally at Home in Marsh and Upland Cover Are Curly-coated and Flat-coated Retrievers

Result of a Slippy-eek: Is the Chesapeake Bay Retriever, a Native American Sporting Dog

Labrador Retriever Gets Its Name from a Geographical Map

[illegible]

participated in few formal trials and have demonstrated their adaptability to various readily to their work in retrieving tests.

Since the dogs are not expected to flush the game, judges of retriever trials enjoy great latitude in arranging the tests. These can be made progressively more difficult as the competition in a big stake narrows down to a few dogs.

Judges can direct how far ahead of the dogs the birds are to be released and can govern, to some degree, the type of cover in which they are to be brought down for a land test, or how far out in the lake or stream they are to be dropped for water work.

In the third series of the 1945 national championship the dogs confronted a triple retrieve—three birds shot down in front of the retriever and the third dropped in high reeds about fifty yards away in the marsh.

The outstanding test here was the manner in which [illegible] of Deer Creek, a Labrador, marked and remembered three falls. With a minimum of direction he got all three with a speed and dash none who saw him is likely to forget. There was no question in any mind that he remembered the falls perfectly.

The dog with such a memory of course has an advantage over other contenders. But the dog which lacks this faculty can offset it to some extent by the readiness with which it follows the directions of its handler.

Ordinarily, while retrieving the first, a dog will come to [illegible] on the shore. Then it must turn, [illegible], turning at the sound of a whistle and promptly following the hand signals left, right, or straight ahead, as the case may be.

Reason for "Blind Retrieve"

The man hunting waterfowl does not want to be sending his dog out continually, especially when the birds are coming in fast. This has led to the inclusion in virtually every stake of at least one difficult "blind retrieve." For the blind tests birds are planted, and the dog which has had no opportunity to mark a fall is sent after them.

In the course of such a test the retriever usually is required to cross one or more bodies of water and proceed some little distance ashore. Under such conditions a dog which will not take direction readily from its handler is at a tremendous disadvantage.

The dog on a blind retrieve has no way of knowing whether it is seeking a duck floating on a wind-swept bay or a pheasant in the brush ashore.

There are anxious moments for the handler and moments of intense interest for the spectators when a dog, even a good one, [illegible] on such a quest. Starts [illegible] sometimes by not catching the handler's signal and plunging ahead in the wrong direction.

Once a good retriever knows that there is a bird instead of [illegible] water, [illegible] it keeps casting about for the scent. Since, from the point where the dog is dispatched inland, the cover usually makes further hand direction impossible. From there it is nose and scenting until the game is in its mouth, it reappears on the far shore and proceeds to bring the game to hand.

Retrievers Show Mettle in Water

Although in the National Championship, land and water tests are evenly divided—there are six of each—the swift water work, it always seems to me, shows the retrievers at their best.

On a cold autumn day, when the spectators huddle in their warmest hunting clothes, it is thrilling to watch a good retriever unhesitatingly plunge into icy water after a bird or a duck.

Ordinarily one duck presents no great difficulty. The dog sees the bird, has marked it, and goes directly after it. Getting the second is something else, especially if, as is often the case, wind and tide have carried it some distance from the original fall.

Then the dog must be guided [illegible] to swim a long distance in a course that often will break over its head, especially when it is returning toward with the duck in its mouth.

If, at the end of such a test, the dog can deliver the bird smartly to the hand of its master, shake itself, and wag its tail in appreciation of a job well done, he or she is worthy of being classed with champions.

Sometimes, since the best of gunners are not infallible, the duck will have been merely winged and hence able to swim strongly. This can work to the advantage of the dog, since a bird that is moving is easier to spot than one floating dead. But the retriever is in for a race that can be both taxing and spectacular.

I recall one contest in which the bird was fully capable of swimming and diving but not of flying. It would go down almost as the dog was on it and then reappear a few feet behind the dog or far to one side. It was a grueling contest for the dog.

That he won is one reason why conservationists contend that a dependable retriever should always be used, especially in hunting waterfowl.

While all trials have their special character-

Bulldogs Which Turn at Dog and Bull Alike Can't Stop His Retreat

[illegible]

[illegible]

Springer vs. Cocker

[illegible]

[illegible]

Proud of a Job Well Done, the Cocker Awaits His Handler in Approved Form

[illegible]

[illegible] a command to fetch, it will dash out and bring the bird back.

As in all other [illegible], the spaniel must honor [illegible] no matter what the temptation. He or she may have been on the scent or flushing its own bird when [illegible] to halt because of the [illegible]. And the dog must remain steady even when, as was the case in [illegible], the bird [illegible] not more than a dozen feet from its own nose.

The flush had been made from a thick clump of bayberry, and the [illegible] to mark [illegible] where the other dog was working.

Throughout that ordeal, with a pheasant lying temptingly under its nose, the first dog [illegible] steady, [illegible] without [illegible]. It was a performance which gave the [illegible] dog a better rating in the [illegible] eyes than the one doing the hunting.

Steadiness, as long as [illegible], is a [illegible] in a spaniel. The natural instinct inherent in most dogs is to [illegible] after the bird has flushed.

The dog which [illegible] after a bird [illegible] the whole course ahead of him [illegible] for the [illegible]. Although this is a cardinal sin in a field-trial dog, I have seen the best of them commit it.

Fleet Too Hasty

I recall one time when the greatest springer it was ever my privilege to watch, [illegible], was so overwhelmed by the instinct to get his bird at once that he broke like a puppy. He [illegible] of [illegible] pheasant [illegible] out the other side.

Up to [illegible] of the [illegible], the [illegible] New York, has [illegible].

As in [illegible] trials, working on tests the [illegible] of a wounded [illegible] bird which has been winged, rather than killed, and has thus [illegible] a runner, able to get away from the spot where it was brought down.

This test is not one [illegible] the handlers [illegible], since the handler ordinarily has no way of knowing that the bird is not where it landed. [illegible] further [illegible] to [illegible] the dog back to the spot where he thinks the bird is, the retrieve [illegible] be made.

I recall one instance where a bird was brought down in some matted grass at the edge of a road. A moment later, in sight of the [illegible] handler, a bird scurried across the road into underbrush on the other side. The pheasant had been brought down. When the dog reached the spot, he scented the running bird, [illegible] a moment, then darted off toward the trail.

Instead of letting him go, the handler [illegible] him on the trail of the runner. Several times the dog tried to come back, but each time he was ordered out to the [illegible].

Finally the [illegible] trying [illegible] and the dog [illegible] down the road. [illegible] in sight at the edge of the grass was the dead bird which the dog would have brought back quickly if the handler had not been sure that he knew more about the situation than the dog did.

Gaar's Scot Keeps His Head Down

One of the best [illegible] performances I ever watched [illegible] out of the pursuit of a runner.

A pheasant, flushed by a little black Labrador retriever, Gaar's Scot, was brought down on a steep hillside. It had been winged, but it could run as fast as ever.

The dog picked up the scent at the point where the bird had fallen and began a chase [illegible] of which was visible to the gallery. The pheasant zigzagged back and forth up the hill, [illegible] moving downwind away from the dog.

At times the bird was not more than a dozen feet ahead of the dog. [illegible] he had [illegible] up, he could not have missed seeing his prey. His friends in the gallery almost prayed that he would lift his eyes. But he was on a job, not sightseeing. That job called for him to keep his head close to the [illegible].

It would be pleasant to be able to report that Scot made the retrieve. None doubted that he could have done it. But to meet the time schedule of the trial he was called up after the bird had got over the top of the hill, and a substitute was sent after it.

A similar episode, with a happier conclusion, occurred one afternoon at the [illegible] trial at Fort Washington, Pennsylvania. There a pheasant, [illegible] on the top of a hill which provided a grandstand for the gallery, came down in the edge of the woods in the valley.

The bird proved a strong runner, and the cover was so dense that the spectators could not see it as it zigzagged back and forth among the [illegible], trying to shake off the persistent [illegible].

[illegible]—a springer whose name, if memory serves correctly, was Pheasant [illegible]—went straight to the fall and picked up the fresh scent. Like little Scot, she kept her nose faithfully on the trail where, if she had stopped to look about, she might have seen the quarry.

She did a beautiful piece of tracking and finally came up with her bird. It was one of those fortunate breaks, a chance to show persistence and sureness of scent [illegible] of [illegible] and [illegible] which sometimes decide close contests.

Since in [illegible] hunting water [illegible] present a problem, the spaniel trials [illegible] have their water tests. These, however, are merely to prove that a dog will not hesitate to enter water when necessary, so there is nothing complicated about them.

As a rule a dead bird is thrown into the water and the dog is ordered to make the retrieve. A dog which refuses to make the water retrieve is [illegible] for a field trial.

One of the great appeals of field trials is that [illegible] amateur [illegible]. There are, of course, those who have [illegible] to [illegible] expert professionals. But these are few compared with the persons who [illegible] one or two dogs which they have bred and trained themselves.

Sunken Sue Trained on Pigeons

A sensation of the season's spaniel trials was a springer named Sunken Sue. Her owner, a [illegible] who had trained her himself in his own back yard. Unable to afford the time or [illegible] to teach her retrieving, he schooled her on pigeons, which, thanks to modern refrigeration, he could use over and over.

To get the money necessary [illegible] to compete in the big [illegible] after he had scored impressive victories in the Midwest, he worked overtime at [illegible].

His reward was a beautiful [illegible] of [illegible], [illegible] by the one which goes with winning the national [illegible] stake of

the English Springer Spaniel Field Trial Association, the most colorful [illegible] competition [illegible] each autumn at Fishers Island.

[illegible] trials. Hunting clothes [illegible]

[illegible] owners.

Whether the [illegible] ground is the fresh green of spring or the brilliant colors of autumn, it is not surprising that field trials hold a cherished place in the hearts of many people.

Descriptions and pictures of eighteen breeds of bird dogs appeared with the article, "Field Dogs in Action," by Freeman Lloyd, published in the January [illegible] issue of the NATIONAL GEOGRAPHIC MAGAZINE.

Since then two other breeds have gained established places for themselves in the United States: the American Water Spaniel and the Weimaraner.

[illegible]

This Cocker Puppy Knows a Wet Nose Is a Keen Nose

[illegible]

The American Water Spaniel

Although not given official recognition by the American Kennel Club until [illegible], the American Water Spaniel (Plate IX) has been a popular hunting dog for years, especially in New England and the Middle West.

What kept this breed out of the official studbook was the fact that its owners were interested in the dog as a companion in the field and not as a bench show competitor.

The American's origin is obscure, but [illegible] and the flair for water indicate a [illegible] relationship to the Irish water spaniel in its blood.

Slightly smaller than the springer spaniel and larger than the cocker, [illegible] the American cocker.

The coat [illegible] the coldest water or most punishing cover. Like the Irish water spaniel, the American [illegible] spaniels have their [illegible] but it should be well feathered, [illegible]

An eager hunter, this dog [illegible] its game as do other field spaniels.

Field Trial Champion Shed of Arden, Labrador Retriever, Shows His Mettle

[illegible]

The Weimaraner

The [illegible] of the [illegible] of Germany [illegible] the Weimaraner (Plate XIII and page [illegible]) is [illegible] of the Schweisshund [illegible].

The breed was developed by noblemen of the court of Weimar who wanted a distinctive variety of sporting dog for their personal service. It remained its present [illegible] for [illegible] years and [illegible] was so closely held that it was unknown outside of its native [illegible]. It was not offered for [illegible] or sale, and a [illegible] member of the Weimaraner Club was [illegible] to prevent [illegible] from [illegible].

First to Import Breed

In [illegible] Howard Knight [illegible] of Providence, Rhode Island, was [illegible] the club and thus the first [illegible] Weimaraners came into American hands. He brought the first pair to this country and subsequently [illegible] others with [illegible] foundation stock.

Probably the most striking thing about the Weimaraner is its coat, a solid color ranging from silver gray to mouse brown and looking like [illegible].

The eyes [illegible] Weimaraner [illegible] changing in different light or when [illegible] with mood or [illegible]. The tail, cropped to the length of [illegible] inches, [illegible].

From the [illegible] the Weimaraner [illegible] especially [illegible].

Writing under the name of Arthur [illegible], the author of [illegible] the [illegible] Kennel Editor of the New York Sun for more than twenty years.

Split-second Time Runs Today's World

By [illegible] Barnes Cortes and [illegible] Palmer

EVERY [illegible] Washington [illegible] astronomer [illegible] the stars [illegible] the Naval Observatory [illegible]

[illegible]

[illegible]

[illegible] Naval Observatory [illegible] Naval Observatory [illegible] the Nation's time.

Astronomer Rides Moon-governed Clock

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

A Signal Every Second

[illegible]

[illegible]

[illegible]

[illegible]

But in today's [illegible] world, accurate time-keeping is not enough. Time *measuring* is equally important.

To [illegible] accurate measure of time, the National Bureau of Standards [illegible] another and far more important time signal that goes out each second, minutes, the 5th of each month, all day and all night, [illegible] week-to-week.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Light from the Distant Past

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

The Sun[illegible] That Came Too Soon

[illegible]

Even now scientists reach towards [illegible] in [illegible] timing the speed of a shell fired from a cannon, or the speed of a radar beam bouncing back from a ship or plane or [illegible].

Your electric clock is run by current that alternates 60 times a second. If it varies from that, your clock is wrong.

Even the modern watch is accurate to an extent unimagined by the early makers of watches and clocks. Today's average watch does not vary by more than 10 or 12 seconds a day. A good watch has a balance wheel that vibrates 18,000 times an hour. If it is off schedule by as few as 10 times, the watch will gain or lose [illegible] a day.

Latest estimates of manufacturers indicate that perhaps 75 million Americans own watches, one for every two people in the country. That alone is a good illustration of how important time has become in modern civilization.

To furnish accurate time for all these watches and accurately keep our many clocks set, the U. S. Naval Observatory maintains elaborate equipment and a large staff of astronomers and technicians.

[illegible] the method used to check the time [illegible] an astronomer [illegible] passed on the [illegible] passes under a certain [illegible] each night. [illegible] was the way it actually was done. Lying on his back, the astronomer looked upward through a telescope that pointed vertically at the zenith, the point directly overhead in the sky.

Across the center of the telescope's field was stretched a fine hair. As the earth turned, a certain star would come into view in the telescope. When it was right on the hair line, the astronomer would press an electrical key, marking the exact time. On the next night he would do it again, and [illegible] was one sidereal day, or star time.

Photographing Time by the Stars

Today it is done with even greater precision. When the astronomer really wants to see how star time compares with the mean time of the Observatory's master clocks, instead of peering at a star through the telescope, he takes four photographs of the star. About 50 stars are used for the purpose in [illegible] nights.

Two pictures are taken at 45 and 15 seconds before the star crosses the zenith, and two at 15 and 45 seconds after it is due to have passed. An electrical device records the exact times when these pictures are taken according to Observatory clock time. Then,

by careful measurements on the plates it can be determined whether the star reached the zenith when the master clocks said it should.

If there is any difference, the time of sending out the radio time signal is corrected to coincide with the earth's turning. For instance, if the master clocks say the star should reach the zenith at exactly 11 a.m., but it actually arrives [illegible] seconds before 11, then the clocks are that much wrong, and the next time signal is sent [illegible] of a second sooner than it otherwise would be.

[illegible] Observatory keeps several master clocks, [illegible] and [illegible] in the [illegible]. The Observatory [illegible] to [illegible] clocks [illegible] that are the most accurate.

The master clocks [illegible] that they are never [illegible]. [illegible] But it [illegible] that they are wrong, since the astronomers always know just how fast or slow they are. Their error is allowed for in sending out the time signal.

Even with their constant error, these master clocks are far more nearly accurate than the average good clock or watch, and [illegible] for [illegible].

To keep them accurate, the clocks are protected from all outside disturbances. The pendulum clocks tick off their time in a [illegible] vault [illegible] underground, away from vibrations and changing temperatures. Each pendulum swings in a vacuum [illegible] from which the air was [illegible] out, for air resistance would gradually slow down their rate of swing. Each pendulum swings in a different direction, too, so that the vibration of one will not affect another.

Pendulums Viewed Through Periscope

[illegible] the vault [illegible] temperature [illegible] of [illegible] degrees [illegible] Fahrenheit, [illegible] and [illegible] when the pendulums swing. No one ever enters this vault except to make [illegible] repairs, and the swinging pendulums are watched through a periscope from above ground. The pendulum clocks are no longer used in timekeeping. They are now used [illegible] in observations for determining positions of stars, [illegible] calculations.

Vibrating crystals [illegible] the other master clocks [illegible]. They are [illegible] like those in [illegible] but they vibrate in a vacuum. Air resistance would slow down their vibration just as it would a pendulum's swing. They are kept at a temperature that varies no more than [illegible] of a degree.

Electric current keeps the crystals vibrating and once started they vibrate continuously at the same frequency, [illegible] times per second. Clocks run by the vibrating crystals are more nearly accurate than the pendulum clocks because the crystals are not affected by variation in the pull of gravity, which causes slight irregularities in the swing of pendulums even in the underground vault.

Even a change in the level of the water table in the ground will cause enough change in gravity, [illegible], to alter the pendulum's period of swing.

Besides these seven master clocks of its own, the Naval Observatory also uses the master clocks at the Bureau of Standards to help regulate the accuracy of its time service. These clocks, too, are crystal-controlled.

Mother Earth Slowing Down

But absolutely accurate time is a hard thing to come by, for Mother Earth herself is not a reliable timekeeper. Though the time of the earth's rotation [illegible] varies [illegible]. Records show that the rotation apparently speeds up occasionally, then slows down a little.

From [illegible] to [illegible] the earth lost [illegible] of a second in the period of [illegible] years. From 1800 to 1900 it gained slightly more than [illegible] of a second. From [illegible] to [illegible] it lost [illegible] again. Since [illegible] it has been gaining [illegible]. Nobody knows why.

Moreover, despite these erratic gains and losses, the earth's clock is gradually running down like any other. In the long run it is [illegible] about [illegible] in [illegible] years. Astronomers know [illegible] of old eclipses [illegible]. That [illegible] but it is important to astronomers [illegible] of time.

Friction of the tides [illegible] the bottom of the sea [illegible] the main force that is gradually slowing the earth down. Another is the shifting of materials from one place on the earth's surface [illegible] which brings [illegible]. The Mississippi River, transferring millions of tons of silt from the northern United States to the Gulf of Mexico, farther from the center of the earth, does [illegible].

You could even say that the construction of the [illegible], in which [illegible] were taken from below the earth's surface and placed on top of it, caused an infinitesimal slowing down of the earth's rotation. All these make it more difficult for the Naval Observatory astronomers to keep accurate time.

Dots on a Moving Paper Keep Time Signals Accurate

[illegible] of the National Bureau of Standards [illegible] Naval Observatory [illegible]

Time rules today's world [illegible] and [illegible] Modern civilization could not operate if we suddenly were unable to measure time. All kinds of things depend on knowing not only what time it is, but [illegible] how long [illegible] the Nation [illegible] by the Government time signals from the Naval Observatory's [illegible] signal and the Bureau of Standards [illegible] (page [illegible]).

That [illegible] picture in your newspaper showing a [illegible] far-off [illegible] [illegible] could not be [illegible] without [illegible] trouble.

Timing for Pictures and Power

A picture or "telephoto" is placed on a revolving roller. [illegible] Photoelectric [illegible] varying electric impulses [illegible] revolving [illegible] Then the impulses are transformed into light of varying brightness that exposes a negative mounted on another revolving roller.

Both rollers, though [illegible] miles apart, must turn at exactly the same speed, or the picture will be distorted. [illegible] rollers [illegible] synchronized, [illegible] time signals [illegible].

[illegible] eastern United States, [illegible] electric power [illegible] interconnected so that [illegible] draw power from [illegible] located [illegible]. All [illegible] alternating current frequency [illegible] cycles per second. [illegible] current varies [illegible] it cannot be used [illegible] another [illegible] engineers check this current [illegible] for time signals.

When you turn [illegible] radio [illegible] 1,000, or 1,500 [illegible] these figures stand for kilocycles or thousands of cycles per second, the frequency [illegible] station. Each station must keep its own frequency [illegible] with another.

[illegible] of these [illegible] the stations [illegible] and [illegible] stations [illegible] the Federal Communications Commission [illegible] them against

standard frequencies broadcast by the Bureau of Standards.

In some types of radio receivers quartz crystals vibrating at different frequencies separate the waves [illegible] bands of different stations, so you can tune to the one you wish to hear without interference from the others.

In the telephone system, where many conversations travel together over the same wire or cable, each at a different frequency, crystals vibrating at these different frequencies separately cut out (filter) [illegible] in the [illegible] just [illegible] for one [illegible]. Vibrations of these crystals are "tuned" to frequencies.*

When a radio program is put on a national network, clocks in all the stations must be set to exact agreement so that all will cut in and start the program exactly on the second.

Sometimes of some operations are timed down to 1/10,000 of a second or less. One high-speed camera used in photographing the human voice cords [illegible] pictures in one second.

X-ray pictures taken in several [illegible] of a second are now used to reveal what is happening inside machines operating at very high speed.

A ship captain steering toward a strange coast [illegible] his bearings on the beacon sees a lighthouse flashing its beam at regular intervals. Timing the flashes, he notes that they come, say, every five seconds, and that the beam revolves in 15[illegible]. This tells him at once what light it is.

[illegible] all over the world identify themselves with [illegible] keyed to time.

Rewound in Reverse, This Mainspring Will Increase in Strength

[illegible]

[illegible] depend on very accurate time to show the distance of an object, which the radar beam picks up. The [illegible] it takes [illegible] to [illegible] and [illegible] back from a ship or plane, or an iceberg, indicates how far away that object is.

Measuring Millionths of a Second

In war the radar [illegible]. It takes only 1/186,000 of a second for a radar wave to travel to an object a mile [illegible]

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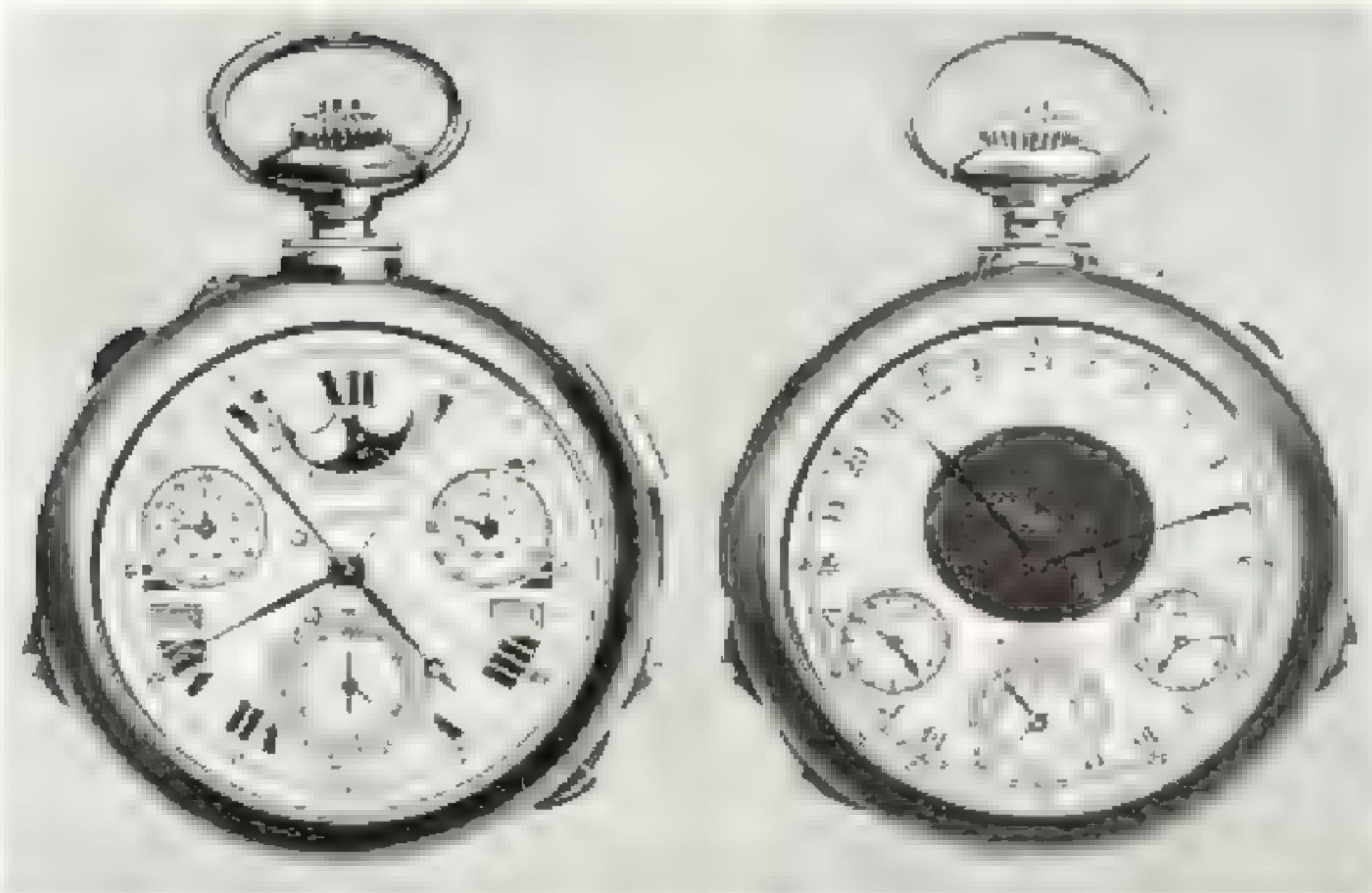
*See, in the National Geographic Magazine, "Miracle [illegible]," by [illegible]; "Miracle Mineral [illegible]," by F. Barrows Colton and [illegible]; "[illegible]," [illegible] 1947.

School Children See One of the Master Clocks That Help Keep the Nation Running on Time

Radio's Sign Language for Talking a Broadcast Employs These Standard Hand Signals

[illegible]



[illegible]

Time Is Only One of Many Things This Two-faced Watch Tells

[illegible] New York [illegible]

[illegible]

By the same principle, the depth of water [illegible] the time [illegible] sound [illegible] to the bottom and back. Knowing the speed of sound in water, [illegible] a depth [illegible] of an inch how deep the water is.

[illegible] Norway [illegible] World War II [illegible]

With [illegible] a navigator [illegible] his position from the difference in time [illegible] signals from [illegible] stations on shore. The difference in their time of arrival [illegible]

Eclipse Study Requires Timing

In [illegible] Brazil in May of [illegible] year scientists of the Army Air Forces–National Geographic Society solar eclipse expedition [illegible] (page [illegible]).

[illegible] in the [illegible] measured by time.

In measuring the force of gravity, the time [illegible] pendulum is very accurately measured.

To determine the slight variations of gravity at different points on the earth, [illegible] the Poles, [illegible] swinging [illegible]

The Way the Earth Is Weighed

[illegible] the earth [illegible] each other [illegible] possible to [illegible] the weight of the earth [illegible]

[illegible] National [illegible]

[illegible] in the National Geographic Magazine [illegible]

This Tiny Hairspring Controls the "Heartbeat" of a Watch

[illegible] The balance wheel [illegible] control the action of the hairspring [illegible]

eardrum, or the air column in the tube of a trumpet or horn. The more vibrations per second, the higher the pitch.

To help piano tuners and musical-instrument manufacturers tune their instruments properly, the Bureau of Standards broadcasts a continuous musical tone on [illegible] WWV [illegible]. It's produced by [illegible] electrical [illegible] at [illegible] cycles per second.

This note is the Nation's "standard of pitch." You can get it any time [illegible] and [illegible] it [illegible].

Government surveys which form the basis for all property lines depend on very accurate measurement of latitude and longitude. To measure longitude you need to know the time to a small fraction of a second. Longitude is distance measured east or west of the Greenwich meridian, an imaginary line that runs through the original site of Britain's Royal Observatory at Greenwich. The Observatory is now being moved to [illegible].

Distance from the Greenwich meridian is measured just [illegible] in time—in hours, minutes, seconds, and fractions of seconds. To get it you have to know the exact time on the Greenwich meridian and the exact time where you are. The difference between the two is your longitude. For example, if it is 12 noon at Greenwich and 7 a.m. at New York City, the longitude of New York is 5 hours west.

Ordinary longitude is [illegible] in degrees, one hour being equivalent to 15°. But Government surveys are made to an accuracy of [illegible] second in longitude.

Without [illegible] a clock that tells very accurate time [illegible] could have no accuracy.

[illegible] determines the correct time at Greenwich. That is [illegible] the positions of certain stars and checking with official [illegible] tables [illegible] (pages 418 and 420).

Congress Turned Time Backward

Congress sometimes used to turn time backward in order to transact its business on time. Formerly, when sessions ended at midnight on March 4, by the clock in the Senate

[illegible]

Carefully Regulated Chronometers Guide U. S. Navy Ships on the Seven Seas

In the chronometer room of the U. S. Naval Observatory [illegible] [illegible] [illegible] A [illegible] [illegible]

or Horse Guards? If all the scheduled business could not be finished in the normal time remaining, the clock was turned back as much as necessary.

Geologists, measuring the age of rock strata in the earth, use a very exact "clock" installed in the rocks by Nature herself. It keeps extremely accurate time. This "clock" consists of radium and other radioactive minerals which gradually disintegrate and change eventually into lead at a constant, known rate of speed.

If you find a deposit of radium in a layer of rock, you will always find with it a certain amount of lead, resulting from the disintegration of some of the radium.

Measuring the amounts of lead and radium, you can tell how much radium was there in the first place, since originally all the lead was radium too. Knowing the rate at which radium turns into lead, you then can figure how long it took for the original radium to change into that much lead. That tells how long ago the process began, and therefore how old the rock layer is. By this method the ages of some rocks have been found to be from [illegible] to nearly 2,000 million years.

But we are chiefly interested in the time we live by, standard time divided into hours and minutes. An hour is a man-made thing, but one twenty-fourth part of the time it takes for the earth to make one complete turn.

Man decided to divide up that time of turning of the earth into 24 hours instead of 20 or 36 or 10, [illegible] [illegible]. It [illegible]

Just Before the Train Leaves, Conductor and Engineer Compare Watches

[illegible]

A New Bar Joins Set Moves to Light the Face of the World's Largest Clock

[illegible]

It's Coffee Time in Bloom by the Coffee-maker Clock

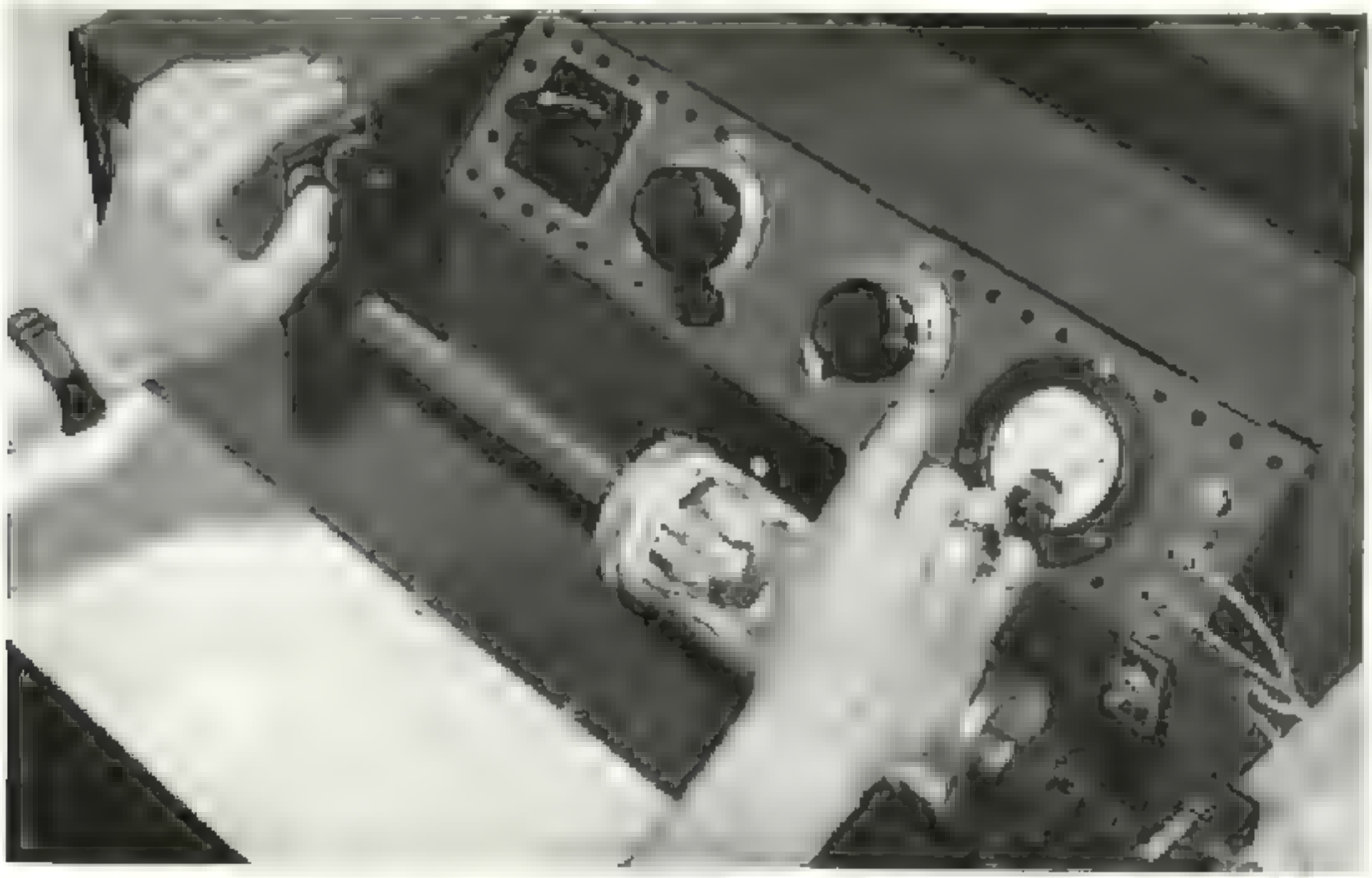
[illegible]

[illegible]

Wrong Time Caused Several Wrecks

[illegible]

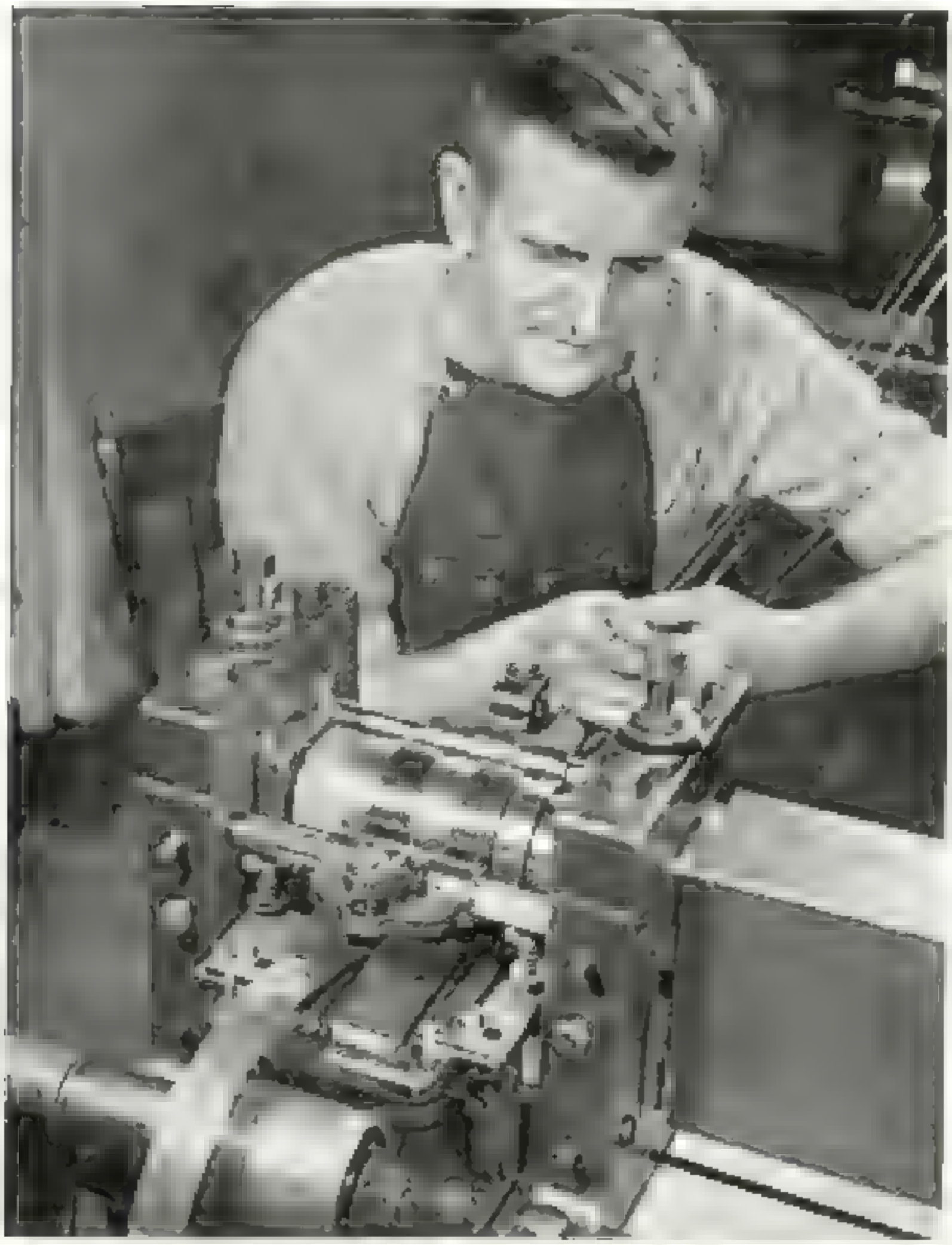
With Tuning, He Can "See" and Measure Twinkling-fast Electrical Impulses



Split-second Timing Is Required to Flash a Wavephone Across the Country

Fig. Five Clock Pendulums Have Told Time for More than 500 Years

[illegible]



He Slices a Band of Elgiloy into Watch Mainsprings

Employee of Elgin National Watch Company [illegible]

So, if we're going east across the international date line we merely [illegible] one day. If we cross the line eastward on Saturday, it means we get another Saturday [illegible]. You have to live through another Saturday before you get to Sunday. But if you're going westward, and cross the line on Saturday, the next day is not Sunday, but Monday. You've lost Sunday altogether.

[illegible] wrote to the Naval Observatory about [illegible] trip across the Pacific going west. [illegible] the transport was scheduled to cross the date line [illegible] Sunday. Would she [illegible] Sunday and the [illegible]

Lost—Eleven Days

Losing time has bothered other people, too. In 1752, when the present calendar was adopted in England 11 days were dropped and England skipped from September 2 to September 14. Many misunderstood the purpose of the Prime Minister who first introduced the change, shouting, "Give us back our eleven days."

at Greenwich, it will be 12 hours later, or 7 a.m. the following day, October 16, at the 180th meridian.

Meanwhile the other man, traveling westward, to keep himself on standard time has to set his watch back an hour every time he passes through another time zone. When he reaches the 180th meridian his watch will show that the time is 12 hours earlier than at Greenwich. If it is 7 p.m. at Greenwich October 15, his watch will say the time is 7 a.m., October 15, the same day. The two men, having traveled [illegible] in opposite directions, find they disagree by one day as to what day it is.

So, to keep things straight it is agreed that

Actually, of course, nobody lost any time. Everybody simply [illegible] 11 days [illegible] by the new calendar than he would have by the old.

Calendar troubles are still with us. It is because the year is measured by the time of the earth's rotation around the sun, and the month by revolutions of the moon around the earth. The earth takes 365¼ days to go around the sun and the moon goes around the earth in 29½ days.

You can't [illegible] the 29½ into the 365¼ and come out even. You have to add a day or two to some months and have a leap year

with an [illegible] day [illegible] [illegible] [illegible] [illegible] leaving [illegible] [illegible] every four years.

Finally [illegible] [illegible] that [illegible] [illegible] [illegible] [illegible] the year [illegible] Caesar's [illegible] [illegible] was [illegible].

[illegible] Pope Gregory XIII decreed that [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] that we still follow [illegible], though [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

Many people [illegible] [illegible] [illegible] [illegible] the calendar [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] Senator [illegible] [illegible] Congress [illegible] [illegible] [illegible] adoption of The World Calendar, which [illegible] [illegible] [illegible] [illegible] equal quarters of [illegible] [illegible]. The [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible].

The Statue of Liberty Might Use This in a Wrist Watch

[illegible]

The [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] an [illegible] [illegible] called "Year End World Holiday." "Leap Year World Holiday" would [illegible] [illegible] of every leap year. Each year [illegible] [illegible] [illegible] [illegible] [illegible] Sunday and [illegible] Saturday. [illegible] [illegible] [illegible] fall [illegible] [illegible] [illegible] [illegible] every year.

Already approved by [illegible] nations, the World Calendar is being considered by the United Nations and the Inter-American Economic and Social Councils.

Daylight saving is setting [illegible] [illegible] [illegible] [illegible] [illegible] daylight [illegible] [illegible] [illegible] of daylight [illegible] [illegible] the day [illegible] [illegible] [illegible] peculiar situation.

Quirks of Daylight Saving

It [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] in [illegible], Delaware. [illegible] [illegible] [illegible] [illegible] line runs [illegible] the middle of State street. On the side in Delaware [illegible] [illegible] daylight time [illegible] [illegible] [illegible] was 8 a.m. when on the other side, in Maryland, which stuck to standard time, it was 7 a.m.

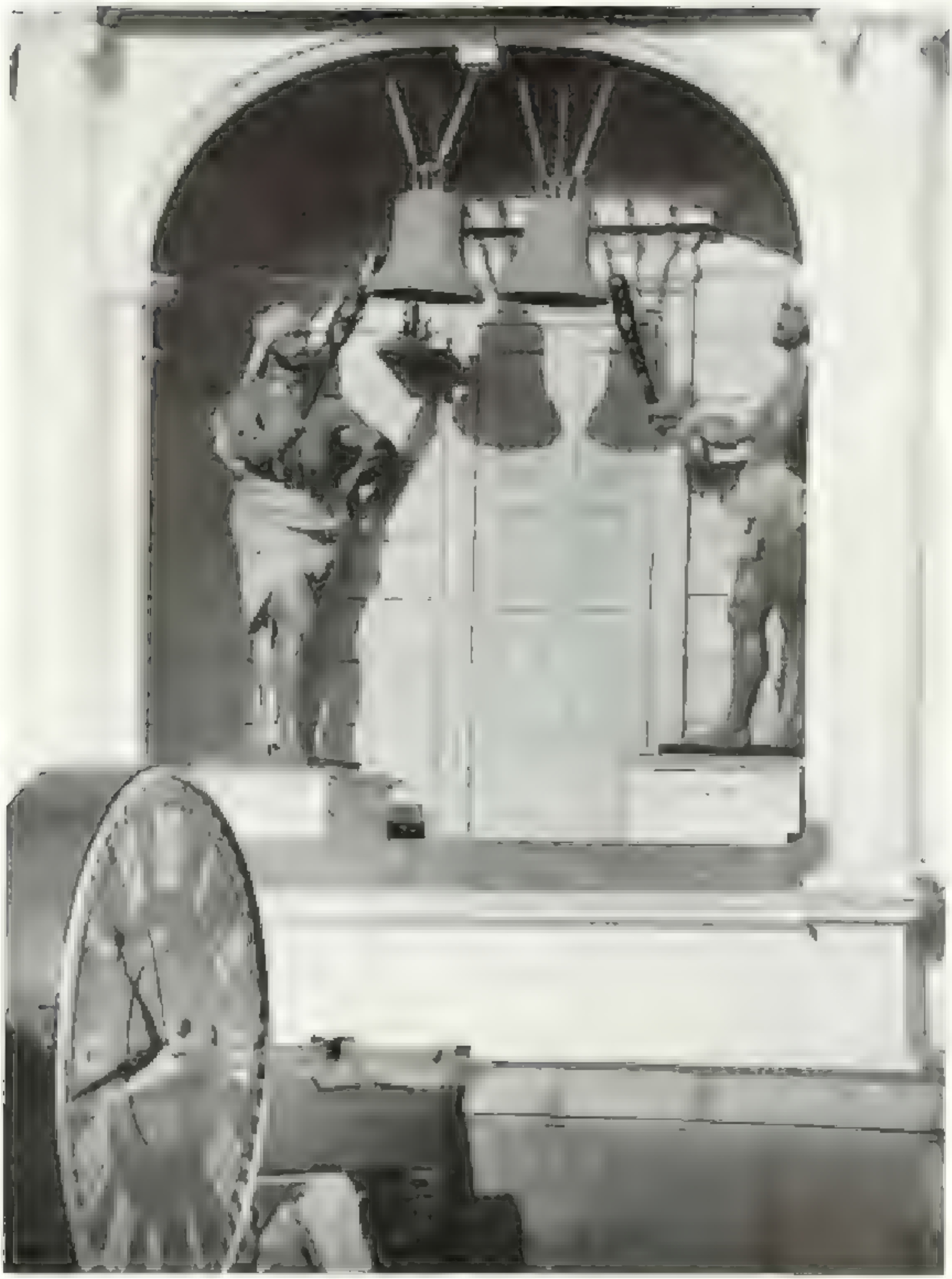
One woman in another town [illegible] by daylight time started [illegible] her [illegible] a few minutes later [illegible] [illegible] [illegible] with the

"I'll Meet You at the Clock"—New York Commuters' Rendezvous in Grand Central Station

[illegible] Photo by Newsweek, N. Y.

Disabled Veterans Learn Watch Repairing by Studying the Enlarged Anatomy of a Watch

At the [illegible] Watchmakers Watch Co. Inc. Edgewater, New York, [illegible] Jewelry Watchmaker [illegible]



Interested Beggars with Clubs Stand Each Quarter Hour in London's Fleet Street

[illegible]

Could You Fit These Parts Back in the Watch and Not Have Any Left Over?

[illegible] to daylight time was made the rule would [illegible], at least, one half hour. When the change came the usual time [illegible] was retained, but at [illegible] she should [illegible] feeding him a few minutes earlier each day.

But our primitive ancestors never worried about daylight saving. It was nothing to them [illegible] sun and moon. Then time-telling devices developed through the centuries to [illegible].

A sundial [illegible] the [illegible] all the [illegible] marked [illegible]. Time was measured by the shadow cast by the [illegible]. Thus the sundial was born.

In the Bible you will read: "And Isaiah the prophet cried unto the Lord: and he brought the shadow ten degrees backward, by which it had gone down in the dial of Ahaz." (II Kings 20: 11.)

Shakespeare refers to a pocket sundial, the great-grandparent of our modern watch, in *As You Like It*, when Jaques says: "He drew a dial from his poke."

Herodotus tells us the sundial came from Babylonia. Those in the valleys of the Tigris and Euphrates [illegible] knowledge [illegible] to all parts of the world, to India, China, Egypt, and Palestine, and eventually to Greece and Rome.

The Greeks Had a Clock for Long Speeches

The ancient Greeks, to time the speeches of their orators, used the water clock, which, like [illegible], the interval [illegible] of water to [illegible] from one receptacle into another. They had a word for it, *clepsydra*, from the Greek words to steal and water. It was also previously known to the Egyptians.

An [illegible] of [illegible] sundial [illegible] found a new conception of time. [illegible] the sundial [illegible] *Forum*.

Pliny the Elder says in his *Natural History* that the clepsydra was introduced into Rome in 159 B.C. The simplest form of clepsydra, and perhaps the earliest, consisted of a vessel of water with a small hole in the bottom. Filled up to a certain height, the water escaped out of the orifice at a [illegible] the same interval of time.

According to a [illegible] speaker who repeatedly [illegible] from a cup of water during his lengthy speech, [illegible] suggested [illegible] that it would be [illegible] to him and to the audience if the speaker were to drink from the clepsydra instead.

Next, the inventive mind of man produced the hourglass or sandglass, which would [illegible] would not spill over, and did not need refilling.

From the 14th century on the sandglass was frequently used in churches to limit the length of sermons. Many a time when the hour was run out the preacher turned the glass over.

Hour and half-hour glasses were in use in the British Navy as late as 1839. And until recently the British House of Commons used a two-minute glass in the procedure for a "division," which is a method of voting.

Later King Alfred of England, seeking to divide his day into equal parts of prayer, work, and rest, told time with six candles, each 12 inches long, which burned at the rate of 20 minutes an inch. One candle lasted four hours—six, 24 hours.

Finding that the candles' burning time varied if there was a draft in the room, he had a case for them made of horn, [illegible]. In early English the covering was called "lanthorn," and from it we get our word "lantern."

On the Palais de Justice in Paris is a clock made in 1370 for Charles V of France [illegible]. [illegible]

Had you lived in the North American colonies [illegible], you would have told the time [illegible]. [illegible] time-telling was important to [illegible].

The bell was an important part of these early timekeepers. The word "clock" comes [illegible] the Middle Dutch *klocke*, the French *cloche*, the German *Glocke*, the Medieval Latin *clocca*, and the Old English *clugge*.

The First True Clocks

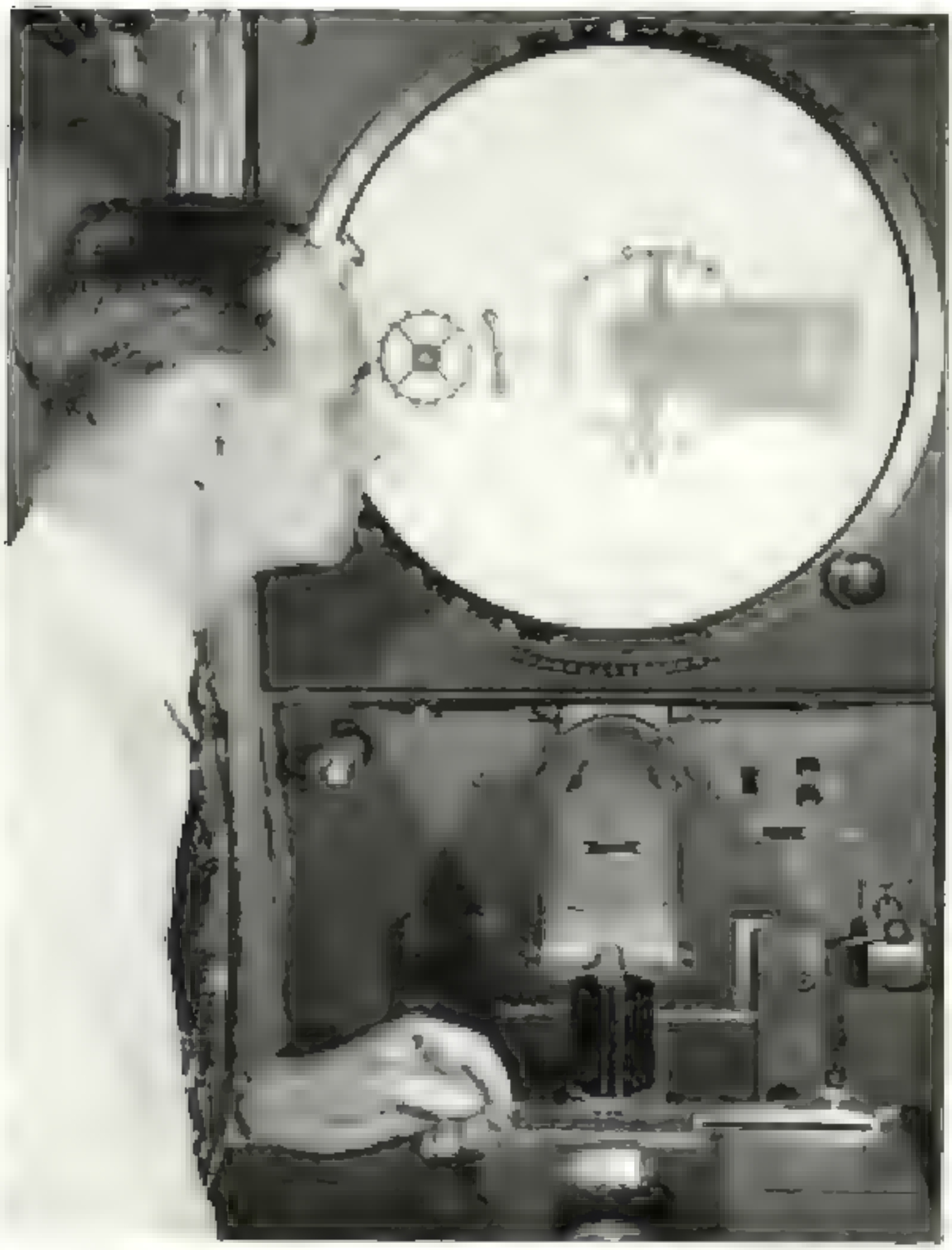
The first true clocks, in the modern sense, of which we have accurate records, appeared in the 13th century. [illegible] had neither hands nor dials [illegible] striking the hours. [illegible] weight [illegible].

About 1335 an English monk constructed the first clock that approached a [illegible]. [illegible] is a [illegible] at Wells Cathedral, England.

Peter Henlein, or Hele, a locksmith of Nuremberg, Germany, invented the mainspring about 1500. In the [illegible] collection

Bears March, a Cock Crows, and Bells Ring to Tell Hours on Perrin's 16th-century Clock

[illegible]



Tiny Clock Faces, Magnified, Are Checked for Flaws

[illegible] Clock Company, [illegible] Connecticut [illegible]

shapes. Many were in the shape of books, [illegible] tulips, stars, [illegible] crosses, [illegible] cockleshells, skulls and [illegible].

[illegible] *[illegible]* [illegible] Walter [illegible]

Jewels, Hairsprings, and Balance Wheels

Queen Elizabeth [illegible] watches to match her [illegible]. Striving to make up [illegible] watchmakers of that [illegible] gold [illegible] enamel and [illegible].

About [illegible] the [illegible] Thomas Tompion perfected the hairspring or [illegible] which [illegible] the accuracy of watches so much that within two years they were on the market with minute hands. Thirty years later Nicholas Fatio, Swiss watchmaker, patented the use of jewels for bearings to reduce friction and [illegible] (pages 4[illegible]).

An important improvement in the accuracy of the watch, the compensated balance wheel, still an essential part today, was introduced in the early [illegible] by George Graham, another English watchmaker.

Next [illegible] Thomas Mudge [illegible]

[illegible] in Mainz, Germany, is the clock-watch believed to have been made by Peter Henlein [illegible] the oldest [illegible] clock-watch in existence (page [illegible]).

This was the first attempt to get the works of a clock down to portable size. About [illegible] high, this clock-watch weighs about [illegible] a pound. [illegible]-shaped case is [illegible] inches in diameter [illegible].

The early clock-watch of 1500 developed into the pocket watch in about one century. At first [illegible] egg-shaped, known as the "Nürnberg egg." [illegible]

When Will This Bank Vault Open? It's a Question of Time!

[illegible]

[illegible] usually carried in the [illegible]

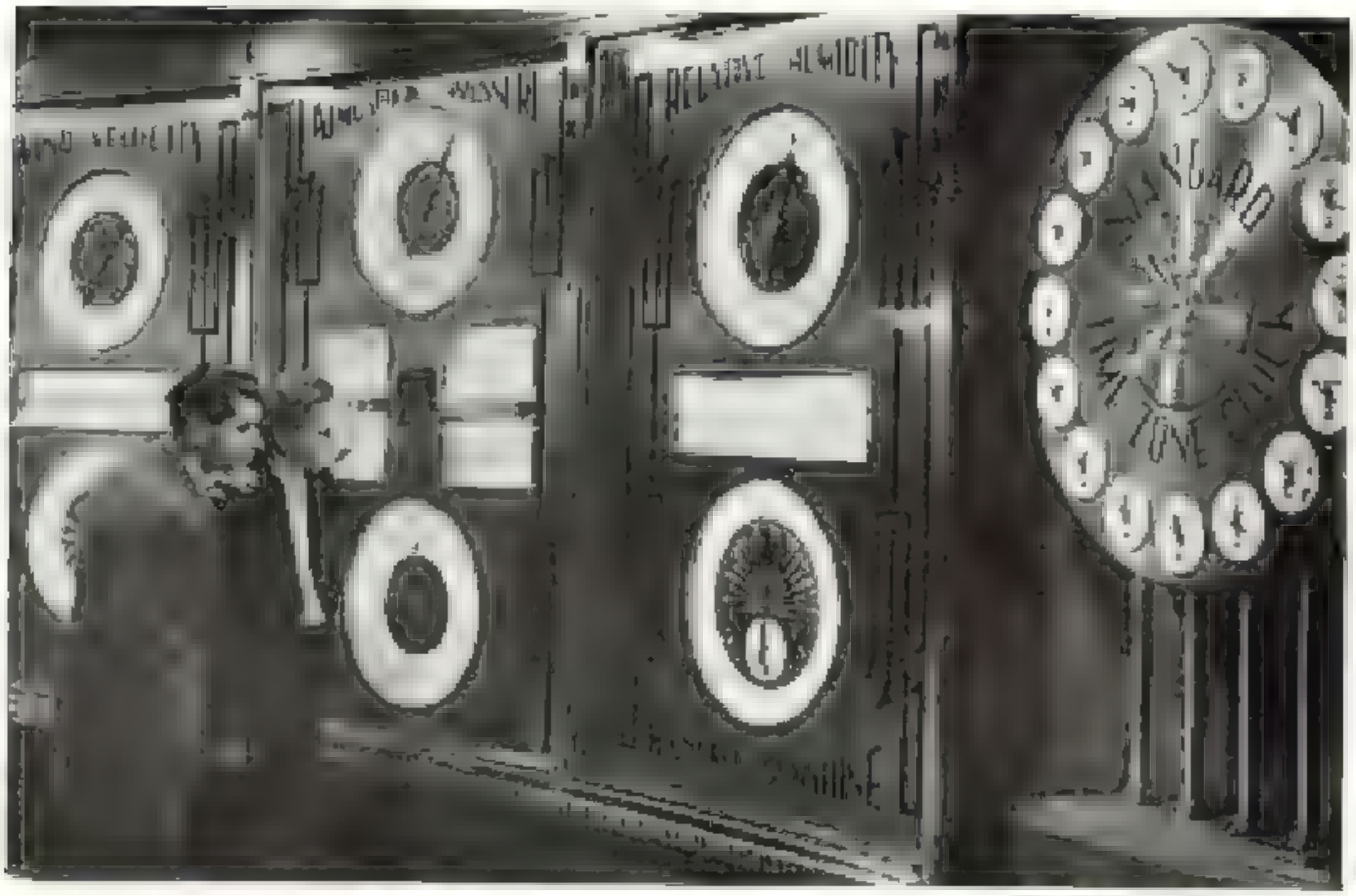
[illegible] prize with [illegible] [illegible] (page 428)

[illegible]

Chronometers Helped Explore the World

[illegible]

[illegible]



Here You Can Check Time All over the World, and the Local Weather as Well!

This Hardness Known Clock-watch Was Fashioned of Iron by Hand (page 42)

[illegible] importance [illegible] clocks were [illegible].

It was customary to buy the works from a clockmaker and to have a [illegible] cabinetmaker make the case. Sometimes the works were hung on the wall without a case. These first [illegible] were known as "wag-on-the-wall" clocks.

An outstanding Connecticut clockmaker, Eli Terry, pioneered in the machinery for quantity production of clocks and established the use of interchangeable parts in clock manufacture. Terry [illegible] of the [illegible] clock parts were [illegible] in the [illegible] with [illegible] shelf clock [illegible] from the long-case clock.

Often Terry traveled on horseback, carrying as many clocks as he could. When the weather looked threatening, the story goes, he would leave a clock at a farmer's house with the understanding that he'd return for it in a few days. Often when he came back the farmer had grown so accustomed to the clock that he didn't want to part with it, and a sale was made.

In partnership with Seth Thomas and Silas Hoadley, Terry contracted to make 4,000 clocks. Friends and neighbors shook their heads and warned him [illegible]. But Terry completed the order within three years.

Seth Thomas, Terry's one-time partner, struck out in 1813 and began business at Plymouth Hollow, now Thomaston, Connecticut. Here in 1853 he formed the Seth Thomas Clock Company, still outstanding in the [illegible].

The World's Biggest Clock

Largest clock in the world [illegible] of the Colgate-Palmolive-Peet Company [illegible] New Jersey, was made by the Seth Thomas company in 1927. The dial, readily visible to ships in New York Harbor, is 50 feet in diameter. The minute hand is [illegible] feet long and weighs [illegible] pounds. The tip of the hand travels [illegible] inches a minute, [illegible] times the distance between two minute marks on an ordinary [illegible].

Two other Connecticut men, Joseph Ives and Chauncey Jerome, pioneered in the production of rolled-brass clocks, which lowered the cost and [illegible] production. Jerome

[illegible]

Lights Go On Again—All over Big Ben

London's [illegible] Westminster [illegible] from the [illegible] New Year's Eve. [illegible] Big Ben [illegible].

[illegible] National Geographic Magazine, September, [illegible].

[illegible] Photograph [illegible]

"The World's Most Accurate Public Clock" Keeps Time for Lower Broadway

A New York [illegible] compares [illegible] with the [illegible] of the [illegible] American [illegible] and Telegraph Company [illegible] Broadway [illegible] 195 Broadway [illegible] the New York [illegible] Company [illegible] Washington [illegible]

[illegible] the [illegible] world [illegible] clocks.

Jerome sold a consignment of brass clocks to England. The price was so low that the [illegible] seized the lot [illegible] undervalued. The penalty under the revenue laws of England was confiscation of the shipment and payment of the invoice price plus 10 percent. Jerome shipped another lot of clocks, and again the English government took them, paying the invoice price plus 10 percent.

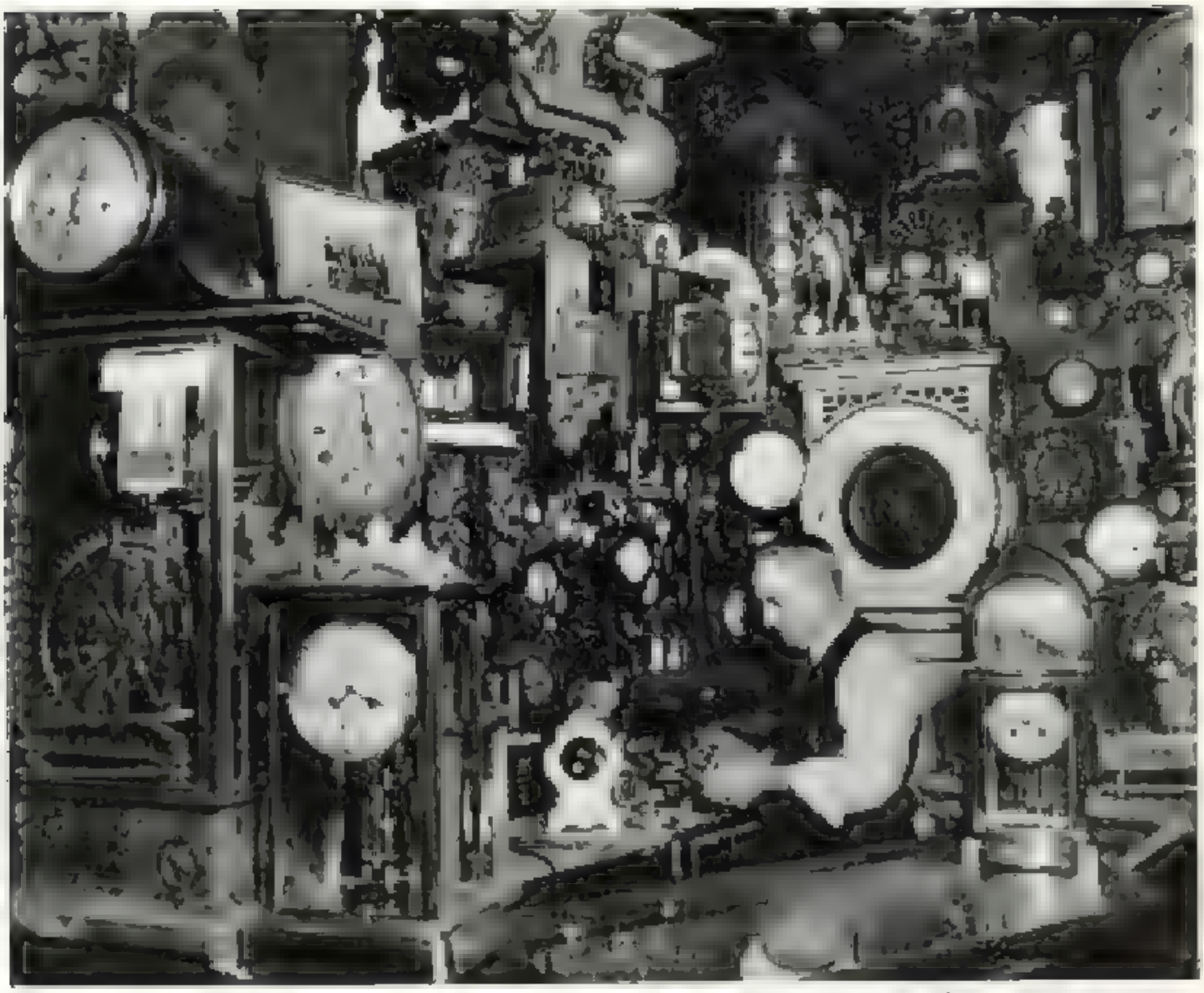
Jerome was satisfied to find an easy cash customer, willing to pay 10 percent over the invoice and no charge for [illegible]. He sent a whole shipload of clocks. [illegible] the English government was losing money, and they [illegible] the [illegible].

Pioneers in the establishment of the first watch factory were two Massachusetts boys, Aaron Lufkin Dennison and Edward Howard, who conceived the idea of making watches by [illegible] (page 425).

Their factory, later known as the Waltham Watch Company, was the first in the world in which all parts of a watch were made by machinery under the same roof. [illegible] in all parts of the world.

[illegible] of the company [illegible] type of [illegible] like a Waltham watch.

[illegible] a watch factory such as those of the Hamilton or Elgin Watch Companies one realizes what [illegible] when he said [illegible] a watch



How Four Generations of Clockwise Jansens Have Kept Up with the Times

[illegible] New York City [illegible]

[illegible] and not get a hair bit soiled.

Look at some of these facts and figures.

The mainspring of a lady's wrist watch is less than 1/8 the diameter of an average human hair (page [illegible]).

The standard unit of measuring a watch is 1/10,000 of an inch. This means that each one of the [illegible] parts when tested must meet this accuracy.

Some watch pivots are finer than a human hair. [illegible] You could put [illegible] of them in a thimble. The largest screw used in one well-known [illegible] watch is [illegible] of an inch long.

To weigh the tiny screws put in the rim of a watch balance wheel to poise its weight, a scale is used that is so sensitive it will record the weight of a pencil mark on a piece of paper.

[illegible] used in watch factories.

Temperature Changes Affect Watches

Though all good watches are tested in six positions (face up, face down, and with the "12" up, down and turned halfway to the left and right), changes of weather also affect watches. [illegible]

Changes in temperature and atmospheric pressure will cause a watch to vary as much as seven or eight seconds a day, [illegible]

You [illegible] a good watch, but do you know why jewels are used in a watch?

They form the same bearings in a watch as [illegible] do in an automobile. Sapphires and rubies are used because they are much harder than metal. The use of jewels

[illegible]

[illegible]

[illegible]